



This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

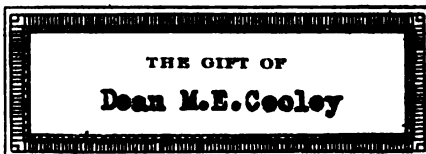
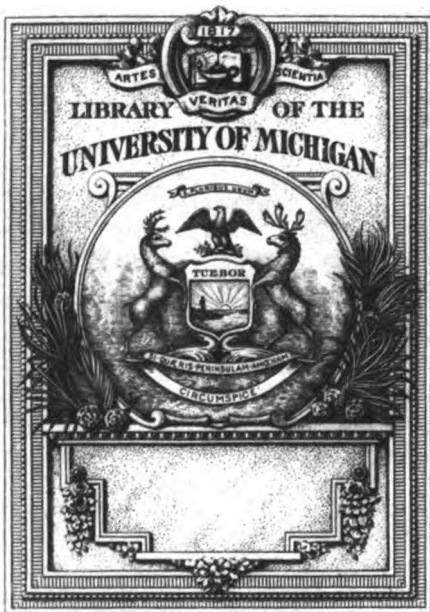
Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

- + *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.
- + *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.
- + *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.
- + *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at <http://books.google.com/>



TA
/ . I 6 m
.. 111

... 100 ...
... 100 ...

MINUTES OF PROCEEDINGS
OF THE
INSTITUTION
OF
CIVIL ENGINEERS.



GENERAL INDEX,
VOLUMES I. TO XX.

SESSIONS 1837 to 1860-61.

LONDON:
Published by the Institution,
25, GREAT GEORGE STREET, WESTMINSTER, S.W.
1865.



LONDON : PRINTED BY WILLIAM CLOWES AND SONS, STAMFORD STREET AND CHARING CROSS.

P R E F A C E.

THIS GENERAL INDEX has been compiled from the twenty-five separate indices attached to the Minutes of Proceedings for each Session, and comprised in the series of Volumes from I. to XX. inclusive. In its preparation the first step taken was to make out a list of the subjects forming the contents of these volumes ; next to indicate, between inverted commas, the exact titles of the different " Papers," under their leading subject-heading, and then to append to these, the analysis of each communication, as previously given, with, in addition, an alphabetical list of the various speakers. It will also be found that, with a view to facilitate consultation, as many cross-references and subordinate entries have been introduced as possible. In every case, the name of the author appears as part of each subject-entry. The name entries were afterwards proceeded with, and in regard to these, it will be observed that they had to be entirely re-modelled. Thus, there is first given, after each name, within brackets, what may be termed the personal history in the Institution of every individual—his

election, the awards he has received, the positions he has filled, etc. Then, alphabetically arranged under each name, are the subjects upon which he has written or spoken at the meetings, corresponding with the main subject-entries throughout the work.

The principal subject and name entries have been printed in capital letters, while the cross-references and minor entries are in ordinary type. It is believed that by the system adopted, it will be an easy task to find what has been communicated in writing to the Institution, or has been spoken at the meetings, on any question, or by any individual, during the period of twenty-five years, to which this General Index relates. At the same time, the members of all classes are earnestly desired to point out any omissions, or errors, they may find, with a view to a corrected copy of the Index being preserved in the Institution.

THE INSTITUTION OF CIVIL ENGINEERS,
25, Great George Street, Westminster, S.W.
February 4, 1865.

MINUTES OF PROCEEDINGS

OF THE

INSTITUTION OF CIVIL ENGINEERS.

GENERAL INDEX.

VOLUMES ONE TO TWENTY.

The Roman Letters refer to the Volume; the Arabic Numerals to the Page.

A.

ABATTOIRS.

ABATTOIRS of Paris.

"Description of the abattoirs of Paris."

By R. B. Grantham, viii. 66.—The butchers' trade in Paris, 66.—Report from the Commission of 1810, upon the evils which existed in Paris, from the slaughter-houses being situated in all parts of the city, 67.—Decree directing the erection of five abattoirs, and table of the names, sizes, and number of slaughter-houses in each, 68.—Markets from which Paris is supplied with cattle, sheep, and calves, 68.—Details of the abattoir of Montmartre, 69.—The slaughter-houses, 69.—The stalls, 71.—Building in which the fat is manufactured into tallow, 71.—The triperies, 71.—Water-supply, 71.—System of collecting the dues, 72.—Statement of the number of cattle which have been slaughtered during the years 1844-5-6-7 at all the abattoirs, 72.—Original cost, and statement of the income and expenditure of all the abattoirs in 1846, 72.—Receipts for the years 1844-5-6, 73.

Discussion.—Armstrong, Sir W. G., 77.

ABERNETHY.

—Ohadwick, E., 74.—Elliott, —, 79.—Fowler, C., 79.—Grantham, R. B., 80, 81.—Leslie, John, 77.—May, C., 77, 81.—Owen, Prof. — 75, 79. — Ransome, J. A., 78.

ABBOTT, Colonel Sir F.

Foundations, Colonel Colvin's method of obtaining, in the north-west provinces of India, xvi. 457.

ABEL, O. D. [Election, xx. 586.]

ABEL, F. A.

Artillery, chemical qualities of the materials for cannon, xix. 872.

ABERNETHY, G. [Resignation, xiii. 133.]

ABERNETHY, G., [Election, xv. 418.]

ABERNETHY, J. [Election, iii. 101.]

Breakwaters. Port of Blyth breakwater, xviii. 115.—Form and construction of breakwaters, xix. 663.

Coffer-dams, construction of, xvii. 553

Docks. Dock walls, xvii. 553.—Victoria (London) Docks, xviii. 477.—Cast-iron wharfing and jetty walls, 477.—Necessity for draining sites of docks, 506, 507.—Past history and present state of the Birkenhead dock works, 508.

Lock-gates. Presumed advantages of wrought-iron gates, xviii. 477.—Hy-

ABSTRACTS.

- draulic power for opening and closing, xviii. 506.
- River Tyne, effect of the enclosure of Jar-row Slake, upon the régime of the, xviii. 523.
- Timber thoroughly creosoted, resists the ravages of the sea-worm, xviii. 438.
- Abstracts of receipts and expenditure, i. (1837) 7; (1838) 9; (1839) 13; (1840) 13; (1841) 17; ii. (1842) 14; (1843) 14; iii. 18; iv. 12; v. 12; vi. 10; vii. 20; viii. 20; ix. 110; x. 102; xi. 116; xii. 124; xiii. 136; xiv. 118; xv. 88; xvi. 100; xvii. 90; xviii. 184; xix. 166; xx. 132.
- Accidents in mines, *Vide* COAL MINES, and MINES; upon railways, *Vide* RAILWAY ACCIDENTS.
- ADAIR, Colonel.
- Artillery. Lient. Rodman's plan for casting heavy guns, xx. 414.
- Defences, national, by works of construction and by artillery, xx. 409.—Of Portsmouth, 410, 412.—Land defences of England, 412.—Of the metropolis, 415.
- Gunpowder, Lient. Rodman's perforated cake, xx. 414.
- Naval construction, &c. Iron-plated ships and the qualities of the material to be employed, xx. 410.—Steam rams, 411.—Floating batteries, 414.
- ADAMS, E. [Election, vii. 184.]
- Roofs. "Description of two wrought-iron roofs over the buildings at Mr. Thomas Cubitt's Works, Thames-bank," i. (1841) 96.
- ADAMS, J. [Election, iv. 211; decease, x. 95.]
- ADAMS, J. Q. (President of the United States.)
- Weights and measures, extracts from his report upon, (Yates, J.), xiii. 293.—Reasons why the French metrical system was not adopted, 297.
- ADAMS, R.
- Fire arms. As to a revolver of his invention, xi. 56.
- ADAMS, W. [Election, xiv. 491.]
- ADAMS, W. B. [Council premium, xii. 116; Telford medal, xvii. 80.]

ADAMS.

- Artillery and rifled ordnance, construction of, xix. 428.—Armstrong and Whitworth guns and projectiles, 430.—Breech-loading cannon for naval purposes, 432.
- Exhibition in 1851, first proposal for making the building like a large conservatory due to him, (Gregory, C. H.), x. 191.
- Fuel. Use of coal, in place of coke, in locomotives, xvi. 39.—As to burning coal with the aid of earthenware fire-balls, 40.
- Locomotive boilers, as to the use of pure water in, xvi. 41.
- Locomotive engine, with a carriage on the same frame, viii. 245.
- Permanent way. "The construction and duration of the permanent way of railways in Europe, and the modifications most suitable to Egypt, India, &c.," xi. 244.—Remarks, 273.—Cost of, 274.—Girder rail, 280.—Expansion and contraction of rails, 288.—Fishing-pieces, 288.—Modifications of forms of rails, 289.—Moveable top for rails, 289.—Barlow's saddle-back rail contrasted with Adams' girder rail, 290.
- "The varieties of permanent way, practically used, or tried, on railways, up to the present period," xvi. 226.—Remarks, 288.—Fish-joint, 289.—Joint fastenings of double T rail, 291.—Engineers holding official positions should not become possessed of all the patents relating to permanent way, 292.
- As to his system for enabling the double-headed rail to be used without chairs, (Gregory, C. H.) xviii. 426.—Materials for permanent way, 441.—Three plans for allowing the double-headed rail to be used without chairs, 441.—Wrought-iron way, on the Great Northern, the London and North-Western, and the North London railways, 442.
- Railway breaks, xvii. 165.
- Shingle, motion of, xi. 215.
- Working classes in the United States and in England, xi. 64.

ADAMS.

Adams' (W. B.) suspended girder-rail, xvi. 275.

ADDAMS, H. [Election, i. (1840) 37.]

ADDISON, J. [Election, vi. 134.]

ADDRESSES of Presidents.

Bidder, G. P., xix. 214.

Cubitt, Sir W., ix. 133; xi. 147.

Field, J., vii. 32; viii. 28; ix. 118.

Locke, J., M.P., xvii. 128.

Rendel, J. M., xi. 148; xiii. 185.

Rennie, Sir J., iv. 23; v. 19; vi. 19; vii. 27.

Simpson, J., xiii. 190.

Stephenson, R., M.P., xv. 128.

Walker, J., i. (1839) 15; (1840) 15; (1841) 23; ii. (1842) 21; (1843) 22; iii. 25; iv. 20.

ADIE, A. J. [Walker premium, ii. (1843) 7, 17.]

Bridges. "On the construction of the bridges on the Bolton and Preston railway," ii. (1842) 176.

Retaining walls of Chorley cutting (Pasley), iii. 367.

Steam gauge. "On the thermometric steam gauge," i. (1838) 15.

ADIE, R.

Metals. "On the corrosion of metals," iv. 323.

ADLEY, O. C. [Telford medal, xii. 115.]

Electric telegraph. "The electric telegraph; its history, theory, and practical applications," xi. 299.—Remarks, 361.—Atmospheric influences upon, 370.

AGNEW, J. A. [Election, xi. 232.]

Agriculture. Use of ammonia for agricultural purposes, ii. (1842) 68.—Gypsum used as manure, 69.—Connection of agriculture with engineering, 144.—Agricultural buildings, 144.—Agricultural chemistry, iii. 296.—Use of chemical manures, 303.—Adaptation of engineering knowledge to the advancement of, v. 111.—Subsoil drainage, 115.—Artificial irrigation, 112.—Use of machinery for, vi. 25.—Nuisances likely to arise from spreading liquid manure over land near towns, vii. 94.—Prospect of the sewage of towns being employed for the fertilisation of land,

AIR ENGINES.

xix. 220. *Vide also* AMMONIA, DRAINAGE, DRAINAGE OF TOWNS, and SEWAGE.

AHER, D. [Memoir, iii. 14.]

AICKIN, G. [Election, xiii. 241.]

AIKIN, A. [Memoir, xiv. 120.]

Brickmaking and pottery. Reference to his "Illustrations of arts and manufactures" (Parkes, J.), ii. (1843) 155.

AINGER, T. E. [Election, ii. (1842) 72; decease, xvii. 107.]

Ainslie's brick and tile machine, ii. (1843) 148.

Air. Friction of air in pipes, i. (1837) 43.

—, action of, upon iron and steel (Mallet, R.), ii. (1843) 171. *Vide also* IRON and STEEL.

— Analysis of the confined air of inhabited rooms, ii. (1843) 185.—Temperature of air on leaving the air-pump, iv. 265.—Friction and resistance of, 280.—In its passage through tubes, in mines, 280.—Robins' experiments for determining the resistance of air to cannon balls, v. 293.—Hutton's ditto to bodies of different forms, and at different velocities, 293.—Edgeworth's comparative experiments, 295.—Beaufoy's ditto, with table of results, 295.—Computations made by Beaufoy from his experiments, 297.—Discharge of, into a partial vacuum, vi. 385, 386.—Hutton's experiments on the resistance of the atmosphere to projectiles, xix. 452.

AIR ENGINES.

"Description of Stirling's improved air engine." By J. Stirling, iv. 348.—Application at the Dundee Foundry, 351.—Fuel consumers, 351.—Less liability to explosion than in steam engines, 352. Discussion.—Cayley, Sir G., 358.—Cottam, G., 356.—Field, J., 357, 360.—Gordon, A., 356, 359.—Homesham, S. C., 357.—Jeffreys, J., 360.—Leslie, J., 358.—Smith, J. (Deanston), 358.—Stephenson, R., 358.—Stirling, J., 355, 356, 357, 358, 359, 360, 361.—Walker, J., 356.

"Description of Sir George Cayley's hot-air engine." By W. W. Poingdestre, ix. 194.—Plan employed by Lieut. Ericsson in Sweden, 195.—Description of a pair of 8 H.P. engines, 195.—Mr.

AIR ENGINES.

Gordon's attempts to propel a boat by the direct application of the products of combustion, 196.

Discussion.—Brunel, I. K., 199, 200.—Gordon, A., 197, 200, 201, 202, 203.—Gurney, G., 198.—Stephenson, R., 200.

"On the use of heated air as a motive power." By B. Cheverton, xii. 312.—Stirling's, and Parkinson and Crosley's air engines, 312.—Ericsson's caloric engine, 312.—Stirling's improvements in 1840, 313.—Ericsson's ditto in 1851, 313.—Difference in construction and arrangement of their two engines, 313.—Caloric in its mechanical aspect, 314.—The true measure of force, 318.—Performances of the caloric engine, 320.—How to utilize, to the greatest extent, a motive force generated by heat, 321.—Office of the 'regenerator,' 321.—Economy of fuel, 323.—Perkins' 'generator,' 323.

Discussion.—Armstrong, Sir W. G., 344, 351.—Bidder, G. P., 347, 350.—Braithwaite, F., 351.—Brunel, I. K., 349, 350.—Crispe, G., 325, *et seq.*—Faraday, Dr., 348.—Fitzroy, Admiral, 350.—Gurney, G., 332, 338.—Hawksley, T., 349.—Lefroy, H. M., 339, *et seq.*—Rankine, W. J. M. 331.—Rendel, J. M., 351.—Bennie, G., 345.—Siemens, C. W., 343, 346.—Spiller, J., 347, 348.

"Remarks on the use of heated air as a motive power." By Sir G. Cayley, Bart., xii. 332.

"On the caloric engine." By C. Manby, xii. 558.—Examination of Ericsson's new engine by M. Galy-Cazalat, 558.—Extract from Ericsson's English specification, 558.—Elastic power of gases, 559.—Deduction from physical laws directly at variance with asserted performance of the caloric ship 'Ericsson,' 560.—To find the mean temperature of the 'regenerator,' before and after the passage of the air, 562.

"On the principle of the caloric, or heated air engine." By J. Leslie, xii. 563.—The 'regenerator' or 'economizer' based on true principles, 563.—Principle of the 'regenerator' as described by the

AIRY.

Rev. Dr. Stirling, 564.—Originality of the invention, 567.—Extract from Dr. Stirling's specification of an air engine patented in November, 1816, 567.—Respective merits of Stirling's and Ericsson's engines, 569.—Details of Stirling's engine, worked at Dundee Foundry for two years and nine months, 570.

"On the conversion of heat into mechanical effect." By C. W. Siemens, xii. 571.—Inquiry into general qualitative and quantitative relations between heat and mechanical effect, 571.—Results obtained in units of power, or foot-lbs., for one unit of heat, by different authors, 574.—Expansion curve of saturated steam, 575.—Expansion of steam behind a piston attended by partial condensation, 576.—Dynamical theory of heat, 578.—Performance of actual engines, including the air engines of Stirling and Ericsson, 579.—Stirling's air engine, as patented in 1816, and improvements in 1827, and in 1840, 581.—Ericsson's engine of 1851, 584.—Imperfections in ditto, 586.—Combined steam and ether engine, 587.—Table of the comparative merits of different steam and air engines, 588.—On the necessary characteristics of a perfect engine, 588.

Discussion.—Armstrong, Sir W. G., 597.—Cowper, E. A., 598.—Clark, D. K., 598.—Hawksley, T., 592.—Manby, C., 591.—May, C., 597.—Pole, W., 594.—Siemens, C. W., 591, 598.—Stirling, J., 599.—Woods, E., 597.

Air Furnace, ii. (1843) 127.

AIRD, J., Jun. [Election, xix. 130.]

AIRY, G. B. [Election, ii. (1842) 184.]

Cheil bank, origin of, xii. 554.

Decimal coinage, &c. Assimilation of the British coinage to that of foreign countries, xiii. 305.—Strict reference of the units of measure and weight to natural standards, 306.—Introduction of the decimal scale generally, 306.—Advantages possessed by a decimal scale, 307.—Weights and measures have a different unit for every class of objects; the

'ALARM' FRIGATE.

multiples of that unit are counted by the decimal scale, and the subdivisions by the binary scale, 308.—Coexistence of the binary and the decimal subdivisions, 309.—Whether a universal decimal scale could, or ought to be enforced, or encouraged by the Government, 309.—Greatest steps rest with private persons, 309.

Electric telegraph, incorrectness of term, xi. 366.—Nature of magnetic storms, and means of registering the currents, 367.—Instantaneous connection between the British observatories and those of the Continent, 368.—Use of, for distributing and establishing correct Greenwich, or uniform time throughout the country, 368.

Exhibition in 1851, construction of the building for the, x. 177.

Steam navigation. Necessity for experiments to determine the ratio of the resistance to the velocity of the ship, xvi. 343.—Means for reducing the loss of power in the use of the screw, 344.

Telegraph cables, submerging, xvii. 298, 359.—Table of the tensions when the cable is payed out from the ship at given angles with the horizon, 299, 359.—Mode of construction of a submarine telegraph cable, 300, 302.—General characteristics of the curve formed by the cable in sinking, 360, 362.—Suppositions adopted in the investigation, 361.—Proper mode of delivery of the Atlantic cable, 361.—Want of data as to the coefficients of resistance and the laws of resistance, 362.—Forces in action in submerging a cable, 366.

Tides, article on, in the "Encyclo. Metr." (Bruff, P.), xx. 358.—Curve representing the law of the rise and fall of the tide at Southampton (Murray, J.), 363.

'Alarm,' frigate, the first copper-sheathed vessel on record, ii. (1842) 66.

ALBAN, Dr. Ernst.

Steam boilers, supposed advantages of an internal flue (Woodcock, W.), xv. 290.

ALBANO, B. [Telford medal, i. (1838) 8.]

Architectural decoration. Specimens of

ALLEN.

a new material called 'Cannabic' composition, iii. 70.

Beams, cast and wrought iron, in combination, vi. 222.

Covent Garden Theatre, alterations at, vi. 222. "Decayed bond-timbers in the walls of Covent Garden Theatre," 255.

Water-meter. "A model and drawing of a lock-meter, used in Lombardy for measuring water for irrigation," ii. (1843) 200.

Water-wheels, iii. 67.

ALBERT, HIS ROYAL HIGHNESS PRINCE. [Election, ii. (1843) 105; iii. 10, 25.]

ALCARD, W. [Election, ii. (1843) 183.]

'A' level, Denton's, iv. 403.

ALEXANDER, H. [Election, i. (1841) 73.]

ALLAN, J. [Election, ix. 57.]

ALLAN, T.

Electro-magnetism as a motive power, xvi. 416.

Telegraph cables, submerging, xvii. 315.—Mechanical construction of the cable, 315.—Comparative advantages of light and heavy cables, 315.—Friction breaks and other retarding machinery, not necessary with cables of light specific gravity, 325.

Allan's submarine telegraph cable, xvii. 245, 315.

ALLCARD, W. [Election, xvii. 367.]

ALLEN, E. E. [Election, xiv. 491; Telford medal, xv. 81, 104.]

Colliers. "On the comparative cost of transit by steam and sailing colliers, and on the different modes of ballasting," xiv. 318.—Remarks, 349.—As to ballasting, 349, 353.—Number of voyages performed by sailing colliers in the year, 363.—Means of discharging cargo, 364.—Dr. White's bag-water ballast, 365.—Screw collier 'Northumberland,' 369.—Screw colliers, 373.

Steam navigation. Desirability of applying auxiliary power and the screw-propeller to the larger class of sailing vessels, xiv. 405.

ALLEN, J.

Scaffolding, revolving, at new Houses of Parliament, iii. 216.

ALLPORT.

ALLPORT, J.

Permanent way. Fowler's joint chairs, on the Manchester, Sheffield, and Lincolnshire railway, xi. 285.

Alumine, silicate of, ii. (1843) 149.

Ammonia decays timber, ii. (1842) 68.—Used as a manure, 68.—From gasworks converted into sal-ammoniac, 68.—Procured from the liquor from gasworks, iii. 291.—Sulphate of ammonia produced in the new mode of purifying gas, 292.—Employment of ammonia for the arts and for agriculture, 297.—Value of ammonia as manure, 298.—Experiments on the use of ammonia in agriculture, 299.—Effect on cut flowers, and for watering plants, 302.—Produce of seed steeped in solution of sulphate of ammonia, 303.—Price of sal-ammoniac, 308. *Vide also Gas.*

AMOS, C. E. [Election, xiv. 523.]

Beacons, floating keel-buoy, xx. 309.

Chronometric governor, Siemens', v. 265.

Safety-valves, xv. 39.

Waterworks. "On the Government waterworks in Trafalgar-square," xix. 21.—Remarks, 30.—Quantity and level of the water in the wells, 30, 51.

Ancholme level, Lincolnshire, account of the drainage of, (Rennie, Sir J.), iv. 186. *Vide also DRAINAGE.*

Anchor, crystallized structure of an, when broken, ii. (1842) 182.

ANDERSON, J.

Artillery. Construction of guns, xix. 357.—Cost of Armstrong 12-pounder, 358.—Built guns, 358.—Ordnance Select Committee, 359.

ANDERSON, W. D. [Memoir, ii. (1843) 13.]

ANDREWS, A. T. [Election, xvii. 128.]

Andrews', Dr., 'Snail-wheel' lock, xiii. 267.

ANDREWS, J.

Rennie, Sir J., portrait of, xii. 111.

Anemometer for mining purposes, Biram's, viii. 137.

Aneroid barometer, viii. 141; xi. 15.

ANGELL, L. [Election, xviii. 406.]

ANIMAL POWER.

"On Mr. Smeaton's estimate of animal power, extracted from his MS. papers."

ANTHRACITE.

By J. Farey, i. (1839) 50. *Vide also HORSE POWER and POWER.*

Annales des Mines de France, proposal for interchange of, for the Transactions of the Institution, ii. (1843) 165.—Presented by the Duke of Buccleuch, 200.—de Russie, presented by the Chevalier Benkhausen, ii. (1843) 200.

ANNUAL GENERAL MEETINGS, i. (1837) 5; (1838) 1; (1839) 15; (1840) 1; (1841) 5; ii. (1842) 5; (1843) 66; iii. 65; iv. 61, 63; v. 160; vi. 57; vii. 73; viii. 1; ix. 90; x. 58; xi. 83; xii. 110; xiii. 121; xiv. 96; xv. 75; xvi. 85; xvii. 68; xviii. 163; xix. 131; xx. 107.

ANNUAL REPORTS OF COUNCIL, i. (1837) 5; (1838) 1; (1839) 1; (1840) 1; (1841) 5; ii. (1842) 5; (1843) 5; iii. 5; iv. 1; v. 1; vi. 1; vii. 1; viii. 1; ix. 92; x. 59; xi. 83; xii. 113; xiii. 124; xiv. 98; xv. 77; xvi. 89; xvii. 71; xviii. 165; xix. 133; xx. 109.

ANSTED, Prof. D. T.

(Chalk. "On the absorbent power of chalk, and its water contents under different conditions," ix. 360.—Remarks, 369.—Specimens experimented upon, 369.—Use of, as a bed for the supply of water, 374.

Mines. Efficiency of Struve's mine ventilator, x. 52.

New red-sandstone, and how far it is similar to chalk, ix. 374.

Stone, Mount Sorrel, for paving, ix. 225.

ANSTRUTHER, Major-General.

Gunpowder, force of, xix. 394.

Iron, cast, want of uniformity in the strength of, xix. 394.

ANTHRACITE.

"On the combustion of anthracite, and its value as a fuel for steam engine and other furnaces." By A. Fyfe, i. (1841) 154.—Objects of Bell's patent furnace, 154.—Advantageously used by means of heated air, 154.—Conditions of experiments, 154.—Results of ditto, 155.—Amount of evaporation by, 155.—Efficiency of the fuel, 155.—Analysis of, 155.—Evaporative power of the fuel, 156.—Rate of combustion, 156. Discussion.—Lowe, G., 156.

APPOLO.

Used in smelting iron (Taylor, J.), ii. (1842) 62. — Strength of iron made with, (Rennie, G.), ii. (1843) 130. — Used for smelting iron at the Ystalyfera iron-works (Glynn, J.), viii. 113, 115. — Mode of using, under a steam boiler, and analyses of three specimens of, by Sir R. Kane, 116.

APPOLO, J. G. [Election, ix. 375; Auditor, x. 59; xi. 83; xv. 75; xvi. 85; Member of Council, xi. 84.]

Axle-boxes, new system of, xviii. 415.

Bells. Experiment of drilling a cracked bell, xix. 19.

Roads. Cost of the repairs of the macadamized road-way on Westminster Bridge, xiii. 235.

Appold's pump, Barker's mill, and Ruthven's propeller, per centages of useful effect, xiii. 373.

AQUEDUCTS.

Ancient Greek, at Patara (Rennie, G.), xiv. 206.

Dudley Port, on the Netherton tunnel branch of the Birmingham canal (Walker, J. R.), xix. 269.

Lisbon. "Description of the great aqueduct at Lisbon, over the valley of Alcantra." By S. Clegg, Jun., i. (1841) 138. — Sources from whence the water is derived, and the mode of conducting it to the reservoir, 138. — Particulars of the construction, 139. — Cost, 140.

—— (Clegg, S., Jun.), xiv. 211.

Maddalone, for conveying water to the Royal Palace of Caserta, near Naples (Poynter, A.), xiv. 234; (Pole, W.), 234.

Negumbode, on the Western Jumna canal (Tremenheere, Maj.-Gen.), xvii. 491.

Nismes, or Pont du Gard. "Description of the Pont du Gard." By G. Rennie, xiv. 236.

Pipe, crossing the Thames, from Putney to Fulham (Simpson, J.), xiv. 523.

Roquefavour. "Description of the bridge-aqueduct of Roquefavour, on the line of the canal of Marseilles." By G. Rennie, xiv. 190. — Peculiarity of the Department of the Bouches du Rhone, 190. — Remains of ancient canals and

ARCHÆOLOGY.

arched tunnels under ground, and of bridge aqueducts, 190. — Origin of the present canal of Marseilles, 190. — Canals for irrigation in the Departments of Vaucluse, Gard, and Var, 191. — Ditto in Dauphiné, 191. — Irrigation in Lombardy, 192. — Popular account of the canal of Marseilles, 193. — Objects of the canal, 197. — Description of the bridge-aqueduct of Roquefavour, 197. — Appendix: dimensions and quantities of materials in ditto, 200.

Discussion. — Bidder, G. P., 208. — Clegg, S., Jun., 211. — Hawkshaw, J., 210. — Manby, C., 223. — Murray, J., 215. — Mylne, R. W., 211, 218. — Papworth, J. W., 209. — Pentland, —, 235. — Pole, W., 202, 233, 234. — Poynter, A., 234. — Rennie, G., 204, 206, 235. — Simpson, J., 218.

Segovia (Beardmore, N.), x. 301.

Solani, on the Ganges canal (Tremenheere, Maj.-Gen.), xvii. 494.

Tivdale, for the Wolverhampton canal (Walker, J. R.), xix. 269.

Washington (Annual Report), xviii. 170.

ARBUTHNOT, G.

Decimal coinage, &c., xiii. 317. — Coins may agree, or differ, in the standard of fineness, 318. — And in their relation to the denomination, or money of account, of the country in which they are circulated, 318. — Unit to be adopted for a decimal system of coinage, 320. — Similar terms in different countries, without identity of value, would produce confusion, 322. — Exchanges, 322. — Coins may agree, or differ, in the metallic standard, 324. — Anomalies in the currencies of different countries have originated in the attempt to maintain a double standard, 325. — The pound sterling as a unit for a decimal system of coinage, 325. — Coin in circulation should correspond in denomination with the money of account, 326. — The penny system offers no advantages in the British relations with foreign countries, 326.

Archæology, how it may be served by engineers, xiv. 103.

ARCHES.

ARCHES.

Ancient, built in concentric half-brick rings in Egypt (Perring, J. S.), ii. (1843) 170.—Origin of the arch (Rennie, G.), iii. 109.—Brick and stone arches of very ancient date, found at Thebes, in the Pyramids, in Greek constructions, &c., 110.—Ancient arches found among Pelasgic remains at Onidus (Page, —), 111.—Arches in the walls of Cēnia, or Cēniade, in Acarnania (Leake, Col.), 113.

Brick and tile. "Experiments on the strength of brick and tile arches." By T. Cubitt, i. (1841) 136.

Cast-iron elliptical. "Account of experiments upon elliptical cast-iron arches." By T. F. Chappé, xviii. 349.—Upon a model of an arch of a bridge proposed to be erected over the river Trent, near Newark, 349.—Upon a model of an arch erected over the Gloucester and Stonehouse and Great Western railways at Standish, 351.—Table showing the pressures to which the arches were subjected in the experiments, 354.

Discussion.—Barlow, W. H., 356.—Bramwell, F. J., 358, 360.—Chappé, T. F., 359, 362.—Fairbairn, W., 356.—Hawshaw, J., 361.—Hemans, G. W., 362.—Locke, J., 361.—Maudslay, H., 359.—Ransome, J. A., 358.—Rennie, G., 356.—Stephenson, R., 360.

Elliptic. "A practical method of forming the stones of an elliptic arch." By W. Bald, i. (1837) 45.

Expansion of. "On the expansion of arches." By G. Rennie, i. (1840) 4.—Experiments to ascertain the effect of temperature on the arches of Southwark bridge, 4.—Ditto at Staines bridge, 5.

Line of equal horizontal thrust in. "On the existence (practically) of the line of equal horizontal thrust in arches, and the mode of determining it by geometrical construction." By W. H. Barlow, v. 162.—First noticed by David Gregory, 162.—Notice of the theory of La Hire and Attwood relative to 162.

ARCHES.

—Ditto of Moseley, 163.—Ditto of Coulomb, 163.—Ditto of Whewell, 163.—Details of experiments relative to, 164.—Ditto of an experiment, showing the analogy between the catenary and the curve of horizontal thrust, 166.—On the geometrical construction of the curve of equal horizontal thrust, 167.—Formula for ascertaining the thickness of abutments necessary to support a given arch, 170.—Remarks on Moseley's researches, on the effect of the adhesion of cements, 171.—Ditto on the application of this theory to practice, 171.

Discussion.—Barlow, W. H., 173, 176, 177, 180.—Bidder, G. P., 175, 176.—Brunel, I. K., 173, 175, 177, 180.—Cubitt, Sir. W., 172, 177.—Inman, W. S., 174.—Pellatt, A., 174.—Snell, G., 178, 181.—Sopwith, T., 173.—Stephenson, R., 174, 176, 177.

Materials for. Propriety of using cement for brick arches, and hydraulic lime for those of stone (Walker, J.), v. 219.—Materials for, and mode of building, piers and arches (Clegg, S., Jun.), x. 300.—Pressures on the piers at St. Paul's, and other remarkable structures (Cowper, C.), x. 241.—On the voussoirs of the Pont-y-tu-Prydd, over the Taff, 241.—Span of arches of Royal Border bridge, at Newcastle (Moorsom, Capt. W. S.), x. 234, 238.

Stability of. "On the stability of arches, with practical methods for determining, according to the pressures to which they will be subjected, the best form of section, or variable depth of voussoir, for any given intrados or extrados." By G. Snell, v. 439.—Division of the paper into sections, 439.—The first section, treating of the general conditions of stability in structures, composed of many blocks of material, as walls, arches, &c., 439.—Problem thereon, to find the position, direction, and amount of the resultant pressure on every joint of a structure, 441.—The second section, on the conditions of stability of an arch whose voussoirs are incompressible, 445.—Problem thereon, to find the

ARCHIMEDES SCREW.

second point of rupture in an arch, ditto, 446.—Two examples on this problem, supposing a hall of 80 feet in width to be covered with a semi-circular vault, and that the depth of the vousoirs at the crown is $\frac{1}{10}$ th of the span, 450, 453.—The third section, on the conditions of stability of an arch, taking into consideration the limited strength of the materials, 454.—Example thereon, on a similar supposition to the foregoing, 456.—The fourth section, on the conditions of stability of an arch acted upon by forces of any amount, applied in any position and direction in the plane of the section; or of an arch whose form is not similar on both sides of the crown, 461.—Problem, to determine the first point of rupture of an arch under the foregoing conditions, with an example, 461.—Appendix I., on the mode of determining the centres of gravity of surfaces, required in the application of the problems, in the preceding articles, 466.—Also on a method of avoiding the repetition of the calculation for every separate portion of the arch under consideration, 467.—Appendix II., being an examination, by the methods described in the paper, into the conditions of the stability of the arch of the Pont-y-tu-Prydd, 468.

Discussion.—Paaley, Lieut-Gen. Sir C. W., 465.—Russell, J. S., 466.—Snell, G., 464, 465, 466, 467, 468.—Stephenson, R., 464.—Stewart, —, 464.

Stone arches, stability of (Fowler, J.), x. 302.

Theory of the arch (Rennie, G.), iii. 107.

Without centering. Model showing a method of erecting an arch without centering (Brunel, Sir M. I.), i. (1838) 11.

Archimedes screw, used for the conveyance of malt, and power required to work it, ii. (1843) 80.

Archimedes screw propeller. *Vide* SCREW PROPELLER.

Architectural decoration, specimens of a new material, called 'Cannabic' composition, for, iii. 70.

ARMSTRONG.

Architecture, v. 109.—Application of iron to, 110.—Use of wood for, 111.

ARITHMETICAL INSTRUMENTS. "The land surveyor's calculator." By G. Heald, i. (1838) 25.—Present of Sir S. Morland's scarce work on "Arithmetick Instruments," 1673 (Farey, J.), iii. 70.—Improved sliding rule (Hoare, C.), xiv. 524.

ARMSTRONG, J. [Memoir, xiv. 147.]

ARMSTRONG, R.

Steam boilers, explosion of, quotation from his opinion as to injury to the arched-boiler bottom (Woodcock, W.), xv. 291.

ARMSTRONG, R.

Steam navigation. "On high speed steam navigation; and on the relative efficiency of the screw propeller and paddle wheels," xvi. 827.—Remarks, 331.—As to whether the propelling-power varies as the square, or as the cube of the velocity, 365.—As to the assertion that form is not necessary in calculations of velocity, 366.—Frictional resistance, 367.—Increase of speed by lengthening the bows of steam-vessels, 367.

ARMSTRONG, Sir W. G. [Election, viii. 206; Telford medal, x. 65; Council premium, xiii. 127; Member of Council, xv. 76; xvi. 88; xvii. 70; xviii. 164; xix. 132; xx. 108.]

Artillery. Rifled ordnance and projectiles, xix. 407.—The three kinds of projectiles hitherto used in the field, 407.—Segment shell, 407.—Time fuze, 409.—Concussion fuze, 411.—Question of long ranges, 412.—Construction of his gun, description of the sights, and process of loading, 413.—Form of carriage originally used, 414.—Effects to be produced by heavy artillery, and species of projectile which would best answer the purpose, 414.—Conditions upon which the attainment of long range chiefly depended, 415.—Proposed 100-pounder gun, and the cast-iron shell designed for it, 417.—Difference between Mr. Whitworth's and Sir W. Armstrong's guns, 418.—

ARMSTRONG.

Pressure required to force the shot through the contracted part of the bore of the Armstrong gun, 420.—Experiments against wrought-iron plates, 420.—Nytoscope, an instrument for enabling gunners to maintain a fire upon any given object after nightfall, 421.—Cost and durability of Armstrong's 12-pounder gun, 423.—Comparison of ranges of Mr. Whitworth's and Sir W. Armstrong's rifled ordnance, 427.—Rifled artillery in use in H. M. service, xx. 471.—Wrought iron the best material for the construction of rifled guns, and the coil principle the best mode of applying that material, 471.—Leaden coating of his projectile, and as to the occasional separation of the lead at the muzzle of the gun, 472.—Three different ways of attaching the lead, and the number of pieces into which the shells burst in each case, 473.—Various specimens of large projectiles, 474.—Difference of the conditions required in the percussion fuze, for sea service and for land service, 474.—'Pillar' fuze, for the sea-service shells of rifled ordnance, 475.—Projectile for the muzzle-loading 'shunt gun,' 478.—Shunt gun, 479.—Development of one of the grooves in the shunt gun, 480.—Breech-closing apparatus arranged to work from the side, 482.—Proposed comparative trials between the Whitworth and the Armstrong guns, 485.—Latest improvements in breech-loading, not patented for his own emolument, 486.—Initial velocity of the shot, and the law of retardation in the projectile, 486, 510.—Experiments with Armstrong and with Whitworth 12-pounder guns at Shoeburyness, 509, 522, 525, 528, *et seq.*—Letters from Sir W. G. Armstrong to the President of the Inst. C.E. and to the Secretary of the Ordnance Select Committee, and reply from the latter, 526.

Caisson, sliding, at Keyham Dockyard, xiii. 458.

Cattle market, Islington, viii. 77.

ARSENALS.

Ericsson's caloric engine, action of 'regenerator' in, xii. 351, 597.

Furnaces, admission of air to, xiv. 26.

Heat, relative expansive effect of, on water and on air, xii. 344.

Hydraulic machinery. "On the application of water pressure, as a motive power, for working cranes and other descriptions of machinery," ix. 375.—Remarks, 384.—Advantages of water-pressure engines, in lieu of steam engines, underground, 384.—Objections to the use of air vessels to prevent concussion, 386.

Pump valves. "On the concussion of pump valves," xii. 450.—Remarks, 456.

Ruthven's method of propulsion by water jets employed on canals, xiii. 212.

Steam boilers, explosions of, xi. 399.

Armstrong's hydraulic machinery at the collier dock belonging to the Regent's Canal Company, near Limehouse, xiii. 250.—At the Sunderland docks, xv. 439.—At the Victoria (London) docks, xviii. 451.—At the Tyne docks, 495.

Vide also HYDRAULIC MACHINERY.

ARNOTT, Dr.

Furnaces, admission of air to, xiv. 21.

Mines, mechanical means for extracting air from, x. 54.

Smoke from the domestic fireplace, prevention of, xiii. 405.

Ventilation, general want of, x. 46.—Warming and, 46.—Construction of air valves and passages, 47.—Curtain-valve applied to H.M.S. 'Anson' in 1845, 47.—Ventilating pumps at Marine barracks, Woolwich, and at other places, 48.

— and PAGE, T.

Drainage of towns. Extract from their reports, on the prevalence of disease at Croydon, and as to the plan of sewerage, xii. 44.

ARNITZ, R. B. [Election, xv. 246.]

ARROWSMITH, W. L. [Election, i. (1841) 163.]

Reservoirs. Description of the Coradino tank, Malta, ii. (1843) 140.

Arsenal, Naval, the late Mr. Rennie's design for, on the Thames, at Northfleet, v. 40.

Arsenals, arrangement of, vi. 22.

ARTERIAL DRAINAGE.

Arterial drainage and outfalls, (Grantham, R. B.), xix. 53. *Vide also DRAINAGE.*

ARTESIAN WELLS.

"On the supply of water from artesian wells." By R. W. Mylne, i. (1839) 59. —Well in Hampstead-road, 60.—Report made by Mr. J. Simpson on ditto, 62.

Rise of water in artesian wells (Buckland, Dr.), ii. (1842) 159; apparently known to the ancients (Bennie, Sir J.), v. 60.—Introduced into England about 1790, 60.—Artesian well at Grenelle (Buckland, Dr.), i. (1841); 167; (Robinson, Sir J.), ii. (1843) 140; (Simpson, J.), xiv. 68; (Prestwich, J., Jun.) 79, 91.—In tertiary sands below London, 91. *Vide also CHALK, LONDON BASIN, WATER SUPPLY, and WELLS.*

ARTHUR, J. K.

Permanent way. Cast-iron sleepers on the Londonderry and Enniskillen railway, xvi. 273.

Artificial harbours, vi. 24.

Artificial horizon, Sir J. Macneill's effort to dispense with the, xi. 24.

ARTILLERY.

As to the bursting of guns (Greener, W.), ii. (1843) 107. —Regularity of vibration in cannons, and in gun-barrels (Parkes, J.), 107.—Cannons cast at the Carron Foundry (Field, J.), 133.—Method of casting ordnance in the United States (Bramwell, F. J.), xviii. 341; (Gregory, C. H.), 341; (Bramwell, F. J., and others), xix. 363, *et seq.*; (Adair, Colonel), xx. 414.

"On the construction of artillery, and other vessels, to resist great internal pressure." By J. A. Longridge, xix. 283.—Investigation of the method of making a gun, which gunpowder, or any other explosive compound, cannot burst, 284.—Difficulty experienced in the manufacture of cylinders of hydraulic presses, when of large size, to resist a comparatively moderate pressure, 284.—Proposal to construct a vessel, by wrapping successive layers of wire round an internal core, and coiling them on with the proper initial ten-

ARTILLERY.

sion, 284.—Similar principle, though different in detail, adopted by Captain Blakely, Mr. Mallet, and Sir W. Armstrong, 285.—Experiments as to the ultimate force of gunpowder, 286.—Cast iron alone does not possess the requisite tensile strength, permanently to resist the internal strain caused by ditto, 288.—Causes of the failure of cast-iron guns, 289.—One source of weakness arises from the variation in the thickness, causing a difference in the rate of cooling, 289.—Amount of strain to which guns are now subjected, 291.—Guns of wrought iron and of steel, 292.—Experiments with Herr Kripp's forged steel gun, 292.—Ditto with a wrought-iron gun made at Gospel Oak, 293.—Ditto to determine the tensile strength of the material of the gun which burst on board the U.S. frigate 'Princeton,' 293.—Ditto, ditto, the iron from which the Mersey Company's monster gun was made, 295.—Construction of a gun in successive layers, with an increasing and definite initial strain from the centre to the circumference, impossible by means of hoops, 296.—Successive states of stress with two, three, and four rings, 299.—Result of a very trifling error in the workmanship, 300.—Method adopted to coil on a quantity of wire with the exact strain indicated by theory, 301.—The same accuracy impracticable with hoops, which also have the defect of want of continuity of substance, 301.—Extract from Captain Blakely's specification for a method of making guns, by the application of rings shrunk on an inner tube, 303.—Capt. Blakely's experiments with an 18-pounder, constructed on this plan, and with a 9-pounder turned down and strengthened from the trunnions to the breech on the same system, 304.—Amount of initial strain to be put on each coil of wire, 306.—Result of experiments to ascertain the effect of powder on brass cylinders without any wire, and with different thicknesses of iron wire, 306.

ARTILLERY.

—Ditto with a brass cylinder, of nearly the same internal dimensions as a 3-pounder mountain gun, 308.—Report from the Ordnance Select Committee as to the failure of ditto on second trial, 309.—The failure attributed to the method of mounting, by which the cylinder had been torn asunder by the recoil, but was not burst, 310.—Experiments to determine the ultimate resisting strength of the fragments of the brass cylinder, 312.—Second series of experiments to try the effect of wire, in enabling hard cast iron to resist a bursting strain, and to ascertain whether the force of gunpowder could be transmitted through a thin breech of cast iron, to a yielding substance placed between that breech and the carriage of the gun, 313.—Further trials as to the strength of cylinders without wire, and with different thicknesses of wire, 316.—Experiments with a small gun constructed on the principle recommended, prematurely stopped by the shot getting wedged in the chase, 317.—Application of the same principle to the construction of the cylinders of hydraulic presses, 319.—APPENDIX:—Force of gunpowder, 322.—Effect of twist, 325.—Amount of lateral deviation due to the axis of the trunnions being 1° out of the horizontal line, 329.—Investigations by O. H. Brooks of the conditions of stress of a cylinder built up of concentric rings, 329.—Ditto, of the effect of rotation in correcting the deviation due to want of symmetry of the projectile, 335.—Ditto, of the amount of error produced by the axis of the trunnions not being horizontal, 336.

Discussion.—Abel, F. A., 372.—Adams, W. B., 428.—Anderson, J., 357.—Anstruther, Maj.-Gen., 394.—Armstrong, Sir W. G., 407, 423.—Bidder, G. P., 338, 400, 421, 448.—Blakely, Capt., 348, 371.—Boxer, Capt., 368.—Bramwell, F. J., 363.—Britten, B.,

ASTRONOMICAL INSTRUMENTS.

349.—Burgoyne, Gen. Sir J. F., 356.—Clay, W., 359.—Conybeare, H., 380, 400.—Cowper, E. A., 373.—Eardley-Wilmot, Col., 403, 422, 423.—Fox, Sir C., 371.—Gregory, C. H., 344.—Haddan, J. C., 361.—Hay, Gen., 401.—Jervis, Capt., 376.—Lancaster, C. W., 376.—Locke, J., 421.—Longridge, J. A., 338, 370, 433.—Longsdon, A., 343.—Moorsom, Capt. W. S., 400.—Noble, Capt., 421.—Pearson, S., 394.—Scott, Commander, R., 366.—Siemens, C. W., 378.—Strode, W., 376.—Tulloch, Col., 423.—Vignoles, C., 360.—Wheatley, Capt., 400.—Whitworth, J., 396, 400, 406, 422, 423.

Changes in, (Bidder, G. P., Jun.), xx. 396.—Best kind of artillery for all uses (Bidder, G. P.), 407. *Vide also* DEFENCES, NATIONAL.

ASHBURY, J. [Election, xviii. 72.]

ASHCROFT, P.

Permanent way. As to 'fishing' ends of rails, on Eastern Counties railway, xi. 276.

Ashley Cutting landslip on the line of the Great Western railway (Thomson, J. G.), iii. 129.

Asphalte, Seyssel, used for roofing and paving, ii. (1843) 96.—Objections to its employment, 96.—Used at the Giltspur-street Compter, 97.—For floors, 97.—Failures generally occasioned by use of inferior materials, 97.—Gas-tar unsuccessfully used, 97.

Asphaltic mastic, i. (1838) 6.

Asphaltic varnish for preventing the corrosion of iron, ii. (1843) 176.

Asphyxia, opinion of Dr. Hall on the action of carbonic acid in cases of, ii. (1843) 191.

ASTON, T.

Artillery. Proposed comparative trials between the Armstrong and the Whitworth guns, xx. 496.—Materials for artillery, 497.—Muzzle-loading 'shunt' gun, 498.

Defences, national, xx. 496.

Astronomical instruments for the Royal Observatory, means for insuring accuracy in the construction of, xvii. 194.

ATCHISON.

- ATCHISON, W. [Election, xx. 292.]
 Athenæum Club, books injured in the library of, ii. (1843) 184.—Mode of ventilation of lamp-burners adopted at, 188.
- ATHERTON, C.
 River Clyde, works by Mr. Telford for the improvement of the, v. 330.
 Steam-navigation, xiii. 40.—Project for effecting the passage between Holyhead and Kingstown at a speed of 22½ miles an hour, 40.—Between New York and Liverpool in six days, 43.—Between England and Calcutta, by vessels capable of carrying sufficient fuel for the whole voyage to Calcutta and back, at a speed of 15 miles an hour, 44.—Reason for selecting H.M.S. 'Rattler' as a type of locomotive efficiency, 53.—Measurement of ships for tonnage, 62.—Necessity for ship-builders supplying a scale of displacement, xiv. 394.—Constructive elements in ten steam vessels, in which the proportion of builders' tonnage, O. M., to nominal horse-power was the same, 399.—Effect of the shape of a ship on the speed, xvi. 334.—Length in proportion to the beam, 335.—Relations of power and speed, 335.—Friction between the hull and the water, 336.—Relative efficiency of screw-propeller and paddle-wheels, 336.—As to high speed, 336.
- ATKINSON, J. S. [Election, iii. 101.]
 Telegraph cable, strains to which a, is liable, in being submerged, xvii. 394.
- ATKINSON, R. T. [Election, ii. (1842) 138; Telford medal and premium, ii. (1843) 6, 17; memoir, v. 5.]
 Mines. "On the sinking and tubbing, or coffering of pits, as practised in the coal districts of the North of England," ii. (1842) 170.
- ATKINSON, W. [Election, xviii. 406.]
 Atlantic and Pacific oceans. *Vide* JUNCTION of the ATLANTIC and PACIFIC OCEANS.
 Atlantic telegraph. *Vide* TELEGRAPH CABLES.

AXLE-BOXES.

- Atmospheric gas-burner, Gurney's, ii. (1843) 190.
 Atmospheric railway. *Vide* RAILWAY, ATMOSPHERIC.
- ATTWOOD, M. W., M.P. [Election, i. (1841) 101.]
 Auger, or 'miser,' for sinking wells, ii. (1843) 59.
 Augers in general use, xvii. 34.
- AUSTIN, C. E. [Election, xvii. 128.]
 AUSTIN, J. G.
 Plotting instrument. Double offset scale, xviii. 404.
 Austin's perforated bricks and blocks, xiii. 205.
 Automaton balance, for weighing coins at the Bank of England (Oldham, T.), ii. (1843) 121.
 Automaton calculator, Roth's, iii. 68.
 Auxiliary power and the screw-propeller, application of, to the larger class of sailing vessels (Robinson, R. A.), xiv. 375. *Vide* also SCREW-PROPELLER; SHIPS and STEAM VESSELS; and STEAM NAVIGATION.
- Avon, River, (Glamorganshire), diverted from its course in forming the harbour of Port Talbot, ii. (1842) 188.
- AXLE-BOXES.
 Curtis's, xviii. 444.
 Mallet's (Mallet, R.), vi. 496.
 New system of. "On a new system of axle-boxes, not requiring lubrication, and without liability to heating." By P. A. de Brussaut, xviii. 406.—Analogous contrivances, 408.—Defect in all the anti-friction apparatus hitherto known, 409.—Way in which the straps of vulcanized textile materials, in the new system, resist the effects of heavy metallic bodies in rapid motion, 409.—Importance of avoiding the use of grease in agricultural implements and in machinery exposed to dust, 410.—Economy of motive power in the new system, 410.—Advantages which will result from the adoption of the new system, 411.—Different kinds of sliding and of rolling, and on the physical laws of traction, 412.
 Discussion.—Appold, J. G., 415.—Fraser

AXLES.

J., 415.—Harrison, T. E., 415.—James,
J., 414.—Lawrence, F., 415.—Locke, J.,
416.—Sinclair, B., 414.

Axles. *Vide* RAILWAY AXLES.

AYRIS, J. [Election, xix. 489.]

AYETON, F.

Isthmus of Suez. Geological features of

AZIMUTH CAP.

the ridge between the Bitter Lakes and
the Red Sea, x. 380.

Timber, action of the worm upon, vi. 55.

AYTOUN, R. [Election, i. (1839) 72.]

Azinuth cap as an addition to the com-
mon level (Cowper, Prof.), i. (1840)
31.

B.

BABBAGE.

BABBAGE, C.

Calculating machines. Scheutz's difference engine, xv. 498.—Mechanical notation, 502.—Scheutz's calculating machine, xvi. 225.

Decimal coinage, &c., xiii. 345.—History of the proposed decimal (pound and mil) scheme as applied to English coinage, 345.—Proposal to coin a piece of silver money of the value of two shillings, 345.—Application of the decimal scale to his calculating machine, and to thermometers, 346.

Mechanical notation, xv. 502.

Pebbles, form assumed by, under water, xii. 547.

Permanent way. Flexure of railway bars, xvi. 384.

BABBAGE, H. P.

Calculating machines. Explanation of some detailed diagrams of Scheutz's difference engine, illustrating the mechanical notation of Mr. Babbage, xv. 497.

BANDELEY, Major J. F. L., R.A. [Election, xvii. 367.]

BAGNALL, J. [Election, i. (1841) 73.]

BAGNALL, T. [Election, i. (1841) 73.]

BAGNALL, W. [Election, i. (1841) 73.]

BAGNELL, J. J. [Election, xi. 68.]

BAGOT, E. [Election, xii. 206.]

BAILLIE, Captain G., B.A. [Election, xx. 191.]

BAILLIE, J. [Council premium, xvi. 93.]

Locomotive boilers. "On the application of volute springs to the safety-valves of locomotive boilers," xv. 28.

Locomotive engines. Extracts from letter as to application of volute springs to engines on the Hungarian and Austrian lines, due and proportionate loading of the springs under an engine, and reasons for employing heavy engines for the conveyance of passengers (Manby, C.), xv. 43.

BALD.

BAILY, E. H.

Stephenson, R., M.P., bust of, presented to the Institution, xii. 111.

BAIRD, Sir C. [Election, i. (1841) 63.]

BAKER, —.

Bridges. Suspension railway-bridge over the Niagara, xiv. 459.

BAKER, E. B. [Election, ii. (1843) 105; resignation, xiii. 133.]

BAKER, W. [Election, vii. 184.]

BAKER, W. L. [Election, i. (1841) 132; Walker premium, iii. 7.]

Hydraulic engines. "Description of a water-pressure engine at Illsang, in Bavaria," ii. (1842) 55.

—"Description of the water-pressure engine at Freyberg, Saxony," ii. (1843) 143.

BAKEWELL, F. C.

Electric telegraph for copying writing, xi. 381.

BALANCE, AUTOMATON.

"Description of the automaton balance for weighing coins, invented by William Cotton, Esq., Governor of the Bank of England." By T. Oldham, ii. (1843) 121.—Notice of the bullion transactions at the Bank, 121.—'Remedy' allowed in the coinage, 121.—Amount of variation in sovereigns, 122.—Amount of gold paid daily at the Bank, 122.—Errors in weighing by hand, 122.—Machine constructed by Mr. Napier, 122.—Comparison between weighing coin by hand and with the automaton balance, 123.—Its freedom from error, 123.

Discussion.—Cotton, W., 124.—Miller, W., 125.—Oldham, T., 123.

Balance spring, laws of isochronism of the, as connected with the higher order of adjustments of watches and chronometers (Frodsham, C.), vi. 224.

BALD, R. [Election, ii. (1843) 183.]

BALD.

BALD, W.

Arches. "A practical method of forming the stones of an elliptic arch," i. (1837) 45.

Blasting. "Account of some blasting operations through the white limestone on the Antrim Coast road, in the north of Ireland," i. (1837) 40.

—— "Further observations on blasting the white limestone of the Antrim Coast," i. (1837) 41.

Harbour, Belfast. "On the velocity of the water in Belfast harbour," i. (1837) 37.

Levelling staffs, i. (1838) 47.

River Clyde, mean-tide level of, v. 314.—Capabilities of, for improvement as a navigation, 315.—Further observations on, 317.—Extracts from various reports on, relative to the importance of the ebbing tidal power, 318.—From those of the late Mr. Rennie, 318.—Mr. Telford, 318.—Mr. Whidby, 318.—Mr. Logan, 319.—Mr. Walker, 319.—Importance of the river to the city of Glasgow, 319.—Channel cut through the Port Glasgow bank, for improving the navigation of the lower Clyde, 319.—Channels cut through the Puddle Deep bank at Garmoyle, the Dumbarton bank, and the Long Dyke bank, 320.—Mode adopted for deepening and clearing the bed of the river between Erskine Ferry and the Newshot Isle, by means of diving-bells and steam-dredgers, 320.—Tidal wave of the Clyde, and Mr. Scott Russell's report thereon, 322.—Expediency of opening the south channel of the river, and its advantages to the navigation, 322.—Table of the velocity of the tidal waters in the river, and remarks on ditto, 324.—Expense of opening the south channel, and its effects, 325.—Mr. Logan's proposal for making a dock, or ship-basin, within the south channel of the Newshot Isle, 327.—Removal of the shoal at Spiers' Hedge, and of a point of land at White Inch, and also at Govan, &c., 328.—Statement of the works executed on the river

BANISTER.

since 1839, 329.—Quantity of materials dredged from the bottom of the river the number of dredgers employed, and the cost, 330.—Weight of the above materials, 331.

Rivers, on testing the quantity of drainage water carried off by, v. 312.

Roads. "On the construction of roads on deep bogs and moss," i. (1838) 50.

Surveys, trigonometrical, of England and Ireland, v. 312.

BALL, J. [Election, i. (1841) 153.]

Ball and socket joints introduced by James Watt for the water-pipes crossing the Clyde, ii. (1843) 135.

BALLARD, S. [Telford medal, i. (1839) 10.]

Bridges. "A description of the turn-bridges on the Herefordshire and Gloucestershire canal," i. (1839) 52.

Ice-breaking. "A method of breaking ice, by forcing it upwards instead of downwards; practised on the Herefordshire and Gloucestershire canal, in the winters of 1834-35 and 1836," i. (1837) 18.—"Description and drawing of the ice-boat," i. (1838) 47.

Lock-gates. "On framing lock-gates without iron work," i. (1839) 31.

Weirs, experiments as to flow of water over, x. 352.

Ballast, artificial, on Birmingham and Gloucester railway, ii. (1842) 55.

Ballasting colliers, xiv. 328.

—— Dublin and Drogheda railway, ii. (1842) 79.

BALLS.

"Description of Mr. Henry Guy's method of giving a true spherical figure to balls of metal, glass, agate, or other hard substances." Communicated by B. Donkin, i. (1837) 22.

BALY, P. P. [Election, xi. 422.]

BAMBOROUGH, —.

Railway breaks, xix. 518.

BAMPTON, A. H. [Election, viii. 164; memoir, xvii. 92.]

BANISTER, F. D. [Election, xx. 258.]

BANISTER, H. [Election, xiv. 278; resignation, xvi. 98.]

BANK-NOTES.

BANK-NOTES.

- Process of wetting the paper for, (Oldham, T.), ii. (1842) 82.
- "On the introduction of letter-press printing for numbering and dating the notes of the Bank of England." By T. Oldham, ii. (1842) 166.—Bramah's numbering-press for, 166.—Oldham's ditto, 166.—Improved numbering-machine described, 167.
- Bank of England, bullion transactions, and automaton balance for weighing coins, ii. (1842) 121.
- Bann reservoirs (Bateman, J. F.), i. (1841) 168; vii. 251.
- BARBER, E. S. [Election, ii. (1843) 68; memoir, xiv. 126.]
- Bar harbours, vi. 22.
- Barker's mill, ii. (1842) 101.
- , Appold's pump, and Ruthven's propeller, per centages of useful effect, xiii. 373.
- BARLOW, Professor.**
- Locomotive engines. "On the comparison between the power of locomotive engines, and the effect produced by that power at different velocities," i. (1839) 46.
- BARLOW, P. W.** [Telford medal, i. (1838) 8; Council premium, xv. 81, 104.]
- Beams, experiments to determine position of neutral axis, xiv. 464, 486.
- Bridges. Swing-bridge over the river Rother, at Rye, xi. 426.—Adaptation of suspension principle to a railway bridge, xiv. 459.—Chain bridges for railways, 486.—Suspension bridge at Inverness, and design for one at Londonderry, xvi. 476, 478.
- Chalk, absorption of water by, ix. 373.
- Girders, of triangular construction, xi. 11.—Corrugated and trough, xvi. 77.
- Iron, wrought and cast, modulus of elasticity in, xvi. 76.—Amount of strain on the upper fibres of a parallel rectangular beam, without large top and bottom flanges, 76.
- Locomotive engines, construction of, viii. 248.—Effects of removing the driving-wheels of an outside-cylinder

BARLOW.

- six-wheeled engine from the centre to behind the fire-box, 248.
- London basin. "On some peculiar features of the water-bearing strata of the London basin," xiv. 42.—Remarks, 66, 93.—Sections and faults, 70.—Definition of term 'water-bearing stratum,' 80.—Infiltration into chalk, 80.—Infiltration of rainfall to subterranean reservoirs, 88.
- Permanent way, construction of, in the United States, vi. 80.—Timber sleepers, viii. 268.—Advantages of a rigid foundation, ix. 226.—Economy and other advantages in the use of cast-iron, instead of timber, sleepers, 402, 404.—Wear of rails, 404, 408.—Cost of permanent way, xi. 273.—Saddle-back rail, 273.—Ordinary rail with cast-iron supports, 273.—Cast-iron bearing-plates, 278.—Cost of maintenance dependent on extent of bearing surface, 278.—Cost of maintaining transverse timber-sleeper way of South-Eastern railway, 279.—Greaves' iron sleepers, 279.—As to preserving timber sleepers, 279.—Cost of maintenance of way, 292.—Rails on South-Eastern railway, 476.—Notice of his cast-iron chair in two halves bolted beneath the rails (Adams, W.B.), xvi. 234.—Ditto of his cast-iron sleepers, 247.—Cast-iron sleepers used on the South-Eastern, on the Enniskillen, and on other railways, 269.—Desirability of substituting iron-sleepers for those of wood, 271.—Results of experiments for testing the strength of different forms of cast-iron sleepers, 271.—Reply to objections to Engineers holding a variety of patents for permanent way, forming themselves into a company, 284.
- Railway, atmospheric. "On the comparative advantages of the atmospheric railway system," iv. 114.—Remarks, 144, 146.—Tractive power of the stationary engine as applied by the atmospheric pipe, 145.—Speed obtained at different points, 274.—Connection between the atmospheric and the stationary systems, 287.

BARLOW.

- Railway systems. Guarantees to railways, xviii. 42.—Increase of the national revenues in Ireland, due partly to the railway system, 42.
- Railways, atmospheric resistance to traction on, v. 289.—Whitstable and Folkestone harbour branches of the South-Eastern railway and mode of working the inclines, xviii. 66.
- Street-paving, advantages of a rigid foundation for, ix. 226.
- Viaducts, comparative cost of timber and brick, ix. 294.—Combination of timber and iron for railway structures, xiv. 505.
- BARLOW, W. H. [Election, iv. 211; Telford medal and Council premium, vi. 1; Telford medal, x. 65.]
- Arches. "On the existence (practically) of the line of equal horizontal thrust in arches, and the mode of determining it by geometrical construction," v. 162.—Remarks, 173.—Line of pressure in arches, 176, 177.—Method of determining ditto, 180, 181.
- , experiments upon elliptical cast-iron, xviii. 356.
- Beams, position of neutral axis in, and resistance to flexure, xiv. 480, 483, 486.
- Bridges, beam, xiv. 483.—Suspension, or chain, for railway purposes, 484.
- Locomotive engines, contrivance in operation on the Midland railway for coal-burning in, xix. 567.
- Permanent way. "Remarks on the different methods of fastening railway bars in their chairs; and a description of a new hollow wrought-iron key," iv. 49.—Remarks, 56.—Cost of the wrought-iron keys, 56.—As to fixing the wrought-iron key in its place, and as to its corrosion, 57.—The supposed effect of the elasticity of the iron key, 57.
- "On the construction of the permanent way of railways; with an account of the wrought-iron permanent way, laid down on the main line of the Midland railway," ix. 387.—Remarks, 401.—Self-recording apparatus for registering the inequalities of the road, 401.—

BARRY.

- Application of his rail to points and crossings, and in stations, 402.—Cost of maintenance, and on the use of stone blocks, 407.—As to his saddle-back rail, xi. 279.—As to permanent way wholly of iron, xvi. 276.—As to the asserted difficulty of keeping the bolts and nuts tight on fish-jointed roads, 277.—Wrought-iron and cast-iron way, xx. 282.
- BARNES, J. [Memoir, xii. 140.]
- Steam navigation, &c. Results obtained in the application of the screw-propeller to the 'Napoleon,' French steam-ship, iv. 165.—Dimensions and power of ditto, 171.—Use of feathering paddle-wheels, 171.
- Barningham's joint for rails, xvi. 239.
- Barometer, experiment with a, constructed with a bent and flattened steel tube, on M. Bourdon's principle, xi. 22.
- , aneroid, viii. 141; xi. 15.
- Barometric observations, xv. 400.
- Barrage of the Nile, x. 379.—Machine for excavating the foundations at the, 368.
- BARREIROS, Colonel J. A. V. [Election, ii. (1843) 155.]
- BARRETT, J. [Election, x. 57; Telford medal, xiii. 127; memoir, xix. 185.]
- Fire-proof buildings. Dr. Fox's system of fire-proof flooring, and the cost, viii. 162.
- "On the construction of fire-proof buildings," xii. 244.—Remarks, 267.—Fusing of cast-iron columns in extensive fires, 267.—Comparative weights of floors of different constructions, 267.—Expansion of iron, 268.—Application of his system of fire-proof construction to the covering of the reservoirs of water-works, 269.—Cost of floors on his system, 271.
- Barron's double-acting tumbler lock, as patented in 1778, xiii. 255.
- Barrow for filling the charges of mine and coke into the blast furnaces at the Butterley ironworks, Derbyshire (Kreeft, S. C.), ii. (1843) 119.
- BARRY, C.
- Stone, artificial, with a silica base, vii. 66.

BARRY.

- BARRY, E. M.** [Election, xix. 263.]
BARRY, F. [Election, xi. 422.]
 Drainage of land. Arterial drainage works in Ireland, xix. 104.
BARRY, J. D. [Election, xviii. 72.]
BARRY, W. H. [Election, xviii. 406.]
 Bars for suspension bridges and other similar purposes (Howard, T.), viii. 273.
BARTHOLOMEW, C. [Resignation, xviii. 182.]
BARTHOLOMEW, W. H. [Election, xvii. 195.]
BARTLETT, T. [Election, iv. 372.]
BARTON, E. [Election, xix. 263.]
BARTON, J. [Election, xii. 352; Telford medal, xv. 81, 104.]
 Beams, wrought-iron. "On the economic distribution of material in the sides, or vertical portion, of wrought-iron beams," xiv. 443.
 Viaducts. Boyne lattice viaduct, on the line of the Dublin and Belfast Junction railway, xiv. 452.—Weight of Britannia tubular bridge compared with Boyne lattice viaduct, 465, 488.—Direction of strains in sides of girders, 477.—Loss of iron at intersections of lattices, 478.—As to bracing, 478.—Victoria tubular bridge over the river St. Lawrence, 478.
BARTON, T. [Election, ii. (1843) 68.]
BASEVI, Lieutenant G. H. [Election, xvi. 458.]
BASSETT, A. [Election, xix. 461.]
BATEMAN, E. L. T. [Telford premium, ii. (1842) 9.]
BATEMAN, J. F. [Election, i. (1840) 83; Telford medal, ii. (1842) 7; Member of Council, v. 142; vi. 46; vii. 56; viii. 44; ix. 91.]
 Fire-proof buildings. Means taken to protect a large cotton-mill at Oldham from fire, viii. 159, 161.—Question of insurance, 161.
 Railway breaks, Mr. Newall's and Mr. Fay's, xix. 524.
 Railway ferries. Original idea of crossing the Frith of Forth by means of a railway vessel, xx. 386.
 Rainfall on high and low lands, vii. 277.
 —Extracts from Mr. Miller's report, as to the gradation in the quantity of rain at different elevations above the

BATSON.

- sea, and the unequal distribution of rain in the climate of Great Britain, 277.—Rainfall in the Longdendale district, and the quantity of water flowing off the ground, 284.—Observations made with funnel rain-gauges at Woodhead, in Longdendale, at Todd's Brook, and at Combs, 287.
 Reservoirs. "Description of the Bann reservoirs, County Down, Ireland," i. (1841) 168; vii. 251.—Remarks, 274.—Advantages of the Bann reservoirs to the mill-owners, 274.—Self-acting balance flood-gates, 274.—Lough Island Reavy reservoir, 274.—Amount of rainfall compared with the water flowing off the ground in different districts, 275.
 Sea walls. Materials for submarine constructions, vii. 198.—Pitched face of the Loch Foyle embankment, 198.
 Shingle, changes in the estuaries of the Exe and the Sid from the motion of, vii. 361.
 Tides, difference in the rise and fall of, at various places, v. 313.
 Water-meters. As to durability of the vulcanized caoutchouc bags in Hanson and Chadwick's meter, xiii. 432.
 Water-supply. Effect of change at Manchester from the intermittent to the constant system of water-supply, xii. 503.—Fire arrangements at Manchester, 503.—Amount of domestic consumption of water, 503.—Water-supply in different districts, xx. 229.
 Waterworks. Construction of thirteen miles of tunnels for the Glasgow waterworks, xix. 279.—Tunnel for the Manchester waterworks, 279.
 Weirs. Difference in the effect of the Lincomb and the Holt weirs on the river Severn, v. 350, 352.—Relative effects of oblique and square weirs, 358.
BATHO, W. F.
 Machines. Batho and Baner's reciprocating drilling-machine and small planing-machine, xvii. 191.
BATSON, R. [Election, i. (1840) 28.]
 Batteries, floating. Application of prin-

BAXENDALE.

ciple of central mooring to floating batteries of large dimensions, xv. 13.—Form of floating body and mooring for ditto, 18. *Vide also DEFENCES, NATIONAL.*

BAXENDALE, J. [Election, i. (1839) 83; Member of Council, ix. 91.]

BAXTER, —. [Memoir, ii. (1842) 13.]

BAYLIS, B. [Election, xi. 422.]

Drainage of towns. Egg-shaped brick sewers at Chester, xii. 82.

BAYLIS, J. [Election, xiii. 64.]

Lights, floating. Proposed circular, wrought-iron, sea-light, tower, xv. 17.—Manner of mooring ditto, 17.—Suggested alterations in details of construction, 17.

Roads. Cost of repairing macadamized roads in London and in Birmingham, xiii. 236.—As to Macadamized roads for the streets of towns, 236.

BAYNES, C. C. C. [Election, ix. 803.]

BAZALGETTE, J. V. N. [Election, v. 248.]

BAZALGETTE, J. W. [Election, i. (1838) 17.]

Drainage of towns. Pipe-drains and brick sewers, xi. 415.—Extracts from his report to the Metropolitan Commissioners of Sewers, as to tubular system of drainage (Doulton, F.), xii. 61.—Sizes of sewers, and materials to be employed in their construction, 66.—As to principle of back drainage by pipes, 68.—Use of pottery pipes for house-drains, 68.—Extract from his report as to the drainage of the district south of the Thames (Harrison, J. T.) xiii. 77.—Remarks on his plan for the sewerage of the north side of the Thames, 86.—As to the proposed main sewer for the drainage of the district south of the Thames, 92.—Experiments made under the direction of the late Mr. Frank Forster on the flux and efflux of the tide in the river Thames, 98.—Exceptions to the proposed use of pumping-power for the drainage of the Metropolis, 100.—Experiments by Trial Works' Committee of Metropolitan Sewers' Commission to determine sizes of sewers, xiv. 290.—Formule for

BEAMS.

determining the velocities of flow through sewers and pipes, 307.—Drainage of the Metropolis, and its effect upon the River Thames, xv. 224.

Reclaiming land from the sea. "On reclaiming land from the sea, with plans illustrative of works in Loughs Swilly and Foyle," i. (1840) 41.

Screw-propeller. Fouling of screws in men-of-war when in action, xiv. 406.

Water-supply for the metropolis, xix. 42.

Beacons, buoys, sea-lights, &c., construction of, (Herbert, G.), xv. 1.

BEACONS, FLOATING.

Beacon on Mr. Herbert's plan, proposed to be placed on the south-west coast of Ireland (Beechey, Admiral), xv. 16.

"On the construction of floating beacons."

By B. B. Stoney, xx. 300.—Two classes, beacon and channel buoys, 300.—Conditions which sea-marks should fulfil, 300.—Buoys whose axis of symmetry is horizontal or oblique, 300.—Can buoy, 301.—Buoys whose axis of symmetry is vertical, 301.—Nun buoy, 301.—Egg-bottomed buoy, 301.—Channel buoys, river Liffey, 302.—Herbert's cone-bottomed buoy, 303.—Keel buoy, 305.—Advantages of ditto, 305.—Application of the keel to floating batteries, 307.

Discussion.—Amos, C. E., 309.—Bidder, G. P., 312.—Bruce, G. B., 309.—Curtis, J. G. C., 311.—Giles, A., 309.—Gordon, A., 309, 311.—Hemans, G. W., 311.—Herbert, G., 310.—Murray, J., 309.—Stoney, B. B., 311.—Vignoles, C., 309.

Vide also BUOYS, BEACONS, SEA-LIGHTS, ETC.

BEAMISH, R.

Thames Tunnel. "Notice concerning the Thames Tunnel," i. (1837) 32.

Tides. On the adoption of the Trinity high-water mark as a datum for tidal reference, v. 314.

BEAMS.

Brick. "On the brick beam at Nine Elms." By C. L. Francis and G. W. Hemans, i. (1838) 16.

BEAMS.

Discussion.—Brunel, Sir M. I., 20.

Brick, erected at the Great Exhibition, Hyde Park (White, G. F.), xi. 478.

Vide also CEMENTS.

Combination of iron and wood for (Bidder, G. P.), vi. 222.

Continuous (Glynn, J.), ix. 273.

— "On a method of computing the strains and deflections of continuous beams under various conditions of load." By J. M. Heppel, xix. 625.—Differs from others in deriving more aid from the theory of couples, and in keeping separate and distinct the two parts of the pressures on the bearing-points respectively from the portions of the beam on either side, 625.—Equations for determining the strains over the bearings and the pressures on the supports, in every case of a continuous beam of uniform section, whose normal condition is straight, 629.—Modification where the spans are of different sections, 629.—Enumeration of the expressions to be employed for the purpose of computation, 630.—Modification of the general expression for the case where, in addition to the distributed loads, there are concentrated loads at the centres of the spans, 631.—Application to the purposes of computation in the case of the Britannia tube, 632.—Example, wrought-iron, boiler-plate girder bridge over the river Cauvery, on the Madras railway, 633.—Strains and pressures at the supports of a continuous rail of infinite length supported at equal intervals, and loaded with a given weight at the centre of one of the spans, 636.—Appendix, derivation of the equations, 639.

Iron. "A series of experiments on the elastic weight and strength of cast-iron beams." By F. Bramah, i. (1837) 45.

—, rule for calculating the strength of, (Fairbairn, W.), iii. 244.—Proper dimensions and proportions of cast-iron beams and columns (Cottam, G.), iv. 348.—Combination of cast-iron beams and wrought-iron tie-rods (Ste-

BEAMS.

phenson, R.), vi. 219.—Mode of spanning large areas in mills, and objections to the combination of wrought and cast iron in beams (Bennie, G.), 222.—As to the use of cast and wrought iron, in combination (Albano, B.), 222.—Proportions between the breaking weight and absolute strength of cast-iron beams (Bennie, Sir J.), 224.—Formula for ascertaining the strength of cast-iron beams, and the difference between it and that which would be applicable to wrought-iron tubular girders (Hodgkinson, Prof.), ix. 250.—Trials of, for the viaduct at Manchester (Bidder, G. P.), xi. 234, 236.

— "On the economic distribution of material in the sides, or vertical portion, of wrought-iron beams." By J. Barton, xiv. 443.—Three kinds of beams considered, viz., tubular or plate, Warren, and lattice, 443.—Duty which sides of a beam have to perform, 444.—Manner in which transmission of weight is effected in plate-beam, 444.—Ditto in Warren-girders, 447.—Ditto in lattice-beam, 447.—Relative practical advantages of each kind of beam, 448.—Relative amount of material required for the sides, or vertical portion of each kind of girder, 448.—Loss of strength by rivet-holes in plate and lattice-beams, and how to be prevented, 450.—Compressive strains on pillars, either vertical or inclined, and how to be met, 450.—Lattice-beams in Boyne viaduct, 451.—Advantages of lattice-beams, 451.—Description of Boyne viaduct on line of Dublin and Belfast Junction railway, 452.—Testing the bridge, 452.—Experiments on light lattice-beams, to test their power of resisting compression, 453.—Position of points of contrary flexure, 455.—Experiment to prove that points where contrary flexure took place in centre span, coincided with those determined by calculation, 456.—Weight of iron in centre span, 457.

Discussion.—Baker, —, 459.—Barlow, P. W., 459, 463, 483, 486.—Barlow, W. H.,

BEAMS.

480, 486.—Barton, J., 465, 477, 488.—Bidder, G. P., 464, 474, 481.—Cowper, E. A., 480, 489.—Doyne, W. T., 460, 488.—Hawkshaw, J., 487.—Hemans, G. W., 467, 474, 489.—Higinbotham, T., 465.—Hood, C., 474.—Manby, C., 459.—Moorsom, Capt. W. S., 487, 489.—Phipps, G. H., 465, 474.—Simpson, J., 490.—Stephenson, R., 468, 474, 479, 481, 486.

Iron. Vertical rib of beams (Stephenson, R.), xv. 193.—Amount of strain on the upper fibres of a parallel rectangular beam, without large top and bottom flanges (Barlow, P. W.), xvi. 76.—Practical rule for calculating the strength of cast-iron beams under transverse strain (Doyne, W. T.), 77.—Forces in action in the case of rectangular beams (Heppel, J. M.), 78; (Cowper, E. A.), 79.

Lattice. "An investigation of the strains upon the diagonals of lattice-beams, with the resulting formulæ." By W. T. Doyne and W. B. Blood, xi. 1.—Model for illustrating the strains, 1.—Strains measured by dynamometer, 2.—Results for beam having parallel top and bottom, 2.—Rules and formulæ deduced from experiments, 4.—Table of strains upon the diagonals of the model, as calculated by the formulæ, and as indicated by the dynamometer, 5.—Application of principles to practice, 6.—Appendix, containing formulæ giving strains upon diagonal bars of diagonally-framed beams, 7.—Case I., semi-beam loaded at the extremity, 7.—Case II., beam supported at the ends and loaded in the middle, 7.—Case III., semi-beam uniformly loaded, 7.—Case IV., beam supported at the ends and uniformly loaded, 8.

Discussion.—Barlow, P. W., 11.—Brunel, I. K., 14.—Cubitt, Sir W., 13.—Doyne, W. T., 10, 11, 12.—Hawkshaw, J., 13.—May, C., 12.—O'Brien, Capt., 12.—Rendel, J. M., 14.

Neutral axis of. "Experiments for determining the position of the neutral axis of rectangular beams of cast and

BEARDMORE.

wrought iron and wood, and also for ascertaining the relative amount of compression and extension at their upper and under surfaces, when subjected to transverse strain." By J. Colthurst, i. (1841) 118.—Compression and extension of, 120.

Discussion.—Cubitt, Sir W., 122.—Donkin, B., 121.—Horne, J., 122.—Vignoles, C., 121.

Neutral axis of. "Remarks on the position of the neutral axis of beams." By Dr. C. Schaffhaeuti, iii. 248.

—, position of, in cast-iron beams (Phipps, G. H.), xvi. 80.—Experiment for ascertaining the effects on a beam under pressure (Sheppard, R.), 81.

Strength of, problem for determining the (Pole, W.), ix. 257.

Vide also BEARERS, WOODEN; BRIDGES, LATTICE; BRIDGES, TUBULAR GIRDER; FIRE-PROOF BUILDINGS; GIRDERS AND TUBES; IRON, Strength of; IRON, wrought and cast; and VIADUCTS, IRON.

BEANES, E. [Election, xiii. 64.]

BEANLANDS, A. [Election, vii. 366; resignation, xviii. 182.]

Railway junctions. "On railway junctions," vii. 204.

BEARDMORE, N. [Election, i. (1838) 26; Telford medal, xiv. 104.]

Aqueduct at Segovia, x. 301.

Breakwaters for deep water and for shallow seas, xviii. 102.—Deep-water pier at Millbay, near Plymouth, 103.

Coal trade of London, xvii. 400.

Coasts of Devon and Cornwall, and the Chesil bank, vii. 361.

Colliers, screw and sailing, comparative cost of discharging, xiv. 356.—Advantages of screw-colliers, 357.

Docks. Tables showing the full theoretical discharge of water due to the observed heads at the new dock-works at Grimsby, ix. 8.—Construction of the Southampton docks, xvii. 551.—River and dock-walls, and the materials to be employed in their construction, 551.

Drainage. As to government supervision of drainage operations, xix. 114.

BEARDMORE.

- Connection between tidal outfalls and land-drainage, and as to the effects of the improvements of the rivers Nene and Thames, 114.
- Horse-power. Labour of a horse drawing on a railway, *ii.* (1843) 119.
- Junction of the Atlantic and Pacific Oceans, by the valleys of the Atrato and Truando, *xv.* 410.
- Masonry for viaducts and other works, *x.* 301.
- Permanent way generally used in Ireland, *xvi.* 383.
- Railway and canal companies, as to the advantages which would result from co-operation between, especially in and near to the Metropolis, *xvii.* 400.
- Rainfall in hilly districts, particularly in the Glencorse district of the Pentlands, *vii.* 285.—In the district of the river Lee, *xiv.* 86.
- Reservoirs. Storage-room required in proportion to the area of drainage ground, *vii.* 286.
- River Lee. "Description of the navigation and drainage works recently executed on the tidal portion of the river Lee," *xiii.* 241.—Remarks, 250.—Observations of the floods in the river Lee, and their effect upon the lower reaches of the Thames, 251.
- . As to the river and its branches, *xiv.* 70.—Rainfall in the district of the Lee, 86.—Improvements on the second division of the river Lee navigation, the Old Ford Locks, the cast-iron pointing-cills, the sluices, and the means of overcoming the water in excavating for the foundations, *xvii.* 399, 405.
- Severn. Works recently constructed upon the river Severn at the Upper Lode, near Tewkesbury, *xix.* 534.—Method which should be pursued in canalising a river, 535.
- Thames. Decrease in the mud above London-bridge, *xv.* 226.—Value of the oscillation of the tide, 226.—Sewerage of the metropolis, 227.—Alterations in the tide consequent upon the increased area of the Thames

BEATTIE.

- and the removal of Old London-bridge, 231.—Comparison of tides in the years 1720 and 1849, 231.—Tidal velocities at spring tides before and after the removal of Old London-bridge, 231.—Difference between the actual level of the tides at London-bridge and at Sheerness, 233.
- Roads. As to the substitution of Guernsey granite, for gravel or flint, for road-making purposes, *xiii.* 236.
- Roofs, weight of, in comparison with span, *xiv.* 270.
- Theodolite. "Description of a double telescope theodolite," *i.* (1841) 96.
- Tides. As to the mean level of the ocean being substantially the same in all parts of the globe, *xv.* 410.
- Tunnels. Section of the strata passed through in the construction of the Netherton tunnel, Birmingham canal, *xix.* 278.
- Water, discharge of. Formulæ commonly used for the discharge of water through pipes, *xiv.* 300, 308.—By large sluices and weirs, and for the flow in rivers and artificial channels, 308.
- Water-mains, joints of, *xiv.* 41.
- Water-wheels in Cornwall, *viii.* 62.
- BEARDMORE, W. [Election, *xix.* 461.]
- Fuel, saving in, by the use of super-heating apparatus, *xix.* 474.
- BEARERS, WOODEN.
- "Results of experiments made with a view to determine the best figure and position for wooden bearers, so as to combine lightness and strength." By J. Horne, *i.* (1837) 30.
- (Horne, J.), *ii.* (1842) 79.
- Bearings for machinery, composition of, *iii.* 88.
- BEATTIE, A.
- Railway axles, form of, *ix.* 302.
- BEATTIE, J. H. [Election, *xvii.* 54.]
- Fuel, consumption of, and average loads of five engines burning coke, and five burning coal, between London and Southampton, *xvi.* 28.—Results of the use of coal in locomotives, 30.
- Locomotive engines. Peculiar features

BEATTY.

and advantages of his coal-burning locomotive engine, xvi, 29.—Report of M. Belpaire on ditto, 29.—Results of the use of coal in locomotives, 30.—Detailed description of his coal-burning locomotive engine, 41; (Clark, D. K.) xix. 550.

BEATTY, J. [Election, xi. 299; memoir, xvi. 154.]

Beaufort ironworks, black-band iron ore found there, ii. (1843) 131.—Hot-blast used at, 181.

BEAUFORT, Rear-Admiral Sir F. [Memoir, xviii. 186.]

BEAZLEY, A. [Election, xx. 106.]

BEAZLEY, S. [Election, i. (1841) 63.]

Beckers' railway siding-stop, x. 58.

Bequerel's galvanometer, common differential, employed in comparing the resistance of two wires, xx. 39.

Bedford Level, drainage of, contrasted with that of Holland, v. 110.—The rivers draining the district; account of the means adopted to reclaim the South, the North, and the Middle levels, xix. 65.

BEECHY, Admiral.

Beacon, floating, on Mr. Herbert's plan, proposed to be placed on the south-west coast of Ireland, xv. 16.

Tides of the English channel (Jackson, R. W.), xx. 352.

BELCHER, Admiral Sir E. [Election, viii. 164.]

Blasting under water, priority in the use of the voltaic battery for, xv. 339.

Buoys, floating beacons, and sea-lights, xv. 11.—Manner of mooring them, 11.

—Pitching of floating bodies in a gale of wind, 15.—Changing the mooring-chain, 15.—Surveying buoys used on the coast of Africa, xx. 310.

Fire-arms, Colt's revolvers, xi. 54.—Desirability of making breech end of the barrel conical, 54.

Harbour at Jersey, original design for the, xviii. 133.

Isthmus of Panamá, and particularly on the materials found there, ix. 89.

Shingle, deposition of, xi. 206, 213.

BELLS.

Soundings, want of a good instrument for deep-sea, xi. 22.

Belfast harbour, velocity of the water in (Bald, W.), i. (1837) 37.

BELL, E. [Election, xiii. 383.]

BELL, H.

Water-supply. Project for bringing water to Glasgow from the falls of the Clyde, and his reasons for not using steam-engines (Mackain, D.), ii. (1843) 134.

BELL, T. (Newcastle-on-Tyne). [Election, x. 326.]

BELL, T. (Bristol). [Election, xiii. 383.]

BELL, T. (West Hartlepool). [Election, xiii. 475.]

BELL, W. [Council premium, xvii. 80.]

Iron. "On the laws of the strength of wrought and cast iron," xvi. 65.

BELPAIRE, M.

Locomotive engines. Analysis of his report on Mr. Beattie's coal-burning locomotive engine (Beattie, J. H.), xvi. 29.

BELLS.

"On the process of raising and hanging the bells in the clock-tower at the New Palace, Westminster." By J. James, xix. 3.—Particulars relating to the clock and bells, from the papers and correspondence ordered by the House of Commons, 4.—Extract from the specification for supplying the five bells, prepared by Mr. E. B. Denison, Q.C., 5.—The first large bell, cast by Messrs. Warner and Sons, 6.—The second large bell, cast by Messrs. Mears, 6.—The four quarter-bells, cast by Messrs. Warner, 6.—The hoisting of the four quarter-bells to the bell-chamber, 6.—Arrangements for raising the large bell, by means of a treble purchase, with large blocks, and a new chain-fall, 6.—The cradle on which the bell rested, 7.—Iron chain-stopper for holding the chain, during the fleeting, on the drum of the crab, 8.—The process of hoisting, and the time occupied, 8.—The carriage from which the bells are suspended, 9.—Experiments upon the bells to ascertain the right

BENKHAUSEN.

weight and proper fall of the hammer, 9.—Discovery of two fractures, 10.—The Rev. W. Taylor, F.R.S., on the other large bells of Europe, 10.—At Lucerne, 10.—At Cologne, 10.—In the church of St. Gudule, Brussels, 11.—At Moscow, 11.—The *Isar Kolokot*, 11.—At Erfurt, 11.—At St. Peter's, York, 11.—Appendix containing details of the time occupied in raising the Great Bell, and the heights lifted, 12.

Discussion.—Appold, J. G., 19.—Bramwell, F. J., 15.—Fry, A., 18.—Greaves, C., 15.—James, J., 18.—May, C., 13, 15, 18.—Mears, G., 15.—Murphy, J., 19.—Papworth, J. W., 18.—Pole, W., 15.—Quarm, T., 13, 14.—Sewell, J., 16.—Smith, W., 14.

BENKHAUSEN, Chevalier G. [Election, ii. (1843) 68.]

Annales des Mines de Russie, presented by him, ii. (1843) 200.

BENNETT, J. [Election, i. (1839) 33.]

BENNETT, J. [Election, ii. (1842) 184.]

Brickmaking, ii. (1843) 147, 148, 153.

BENNETT, S. [Memoir, xix. 186.]

BENNETT, W. C. [Election, xvi. 458.]

BENTHAM, General Sir S.

Caissons for closing the entrances to wet, or dry docks first suggested by him (Fairbairn, W.), xiii. 444.—Floating dam proposed by him for closing the entrance to the great basin in Portsmouth dock-yard (Bentham, Lady,) 459.

Naval construction, &c., water-tight bulk-heads and other improvements in, (Field, J.), iv. 178; (Bentham, Lady), 180.

Timber, improvements introduced by him in machinery for the conveyance of, (Molesworth, G. L.), xvii. 17.

BENTHAM, Lady.

Caissons. Floating dam proposed by Sir S. Bentham for closing the entrance to the great basin in Portsmouth dockyard, xiii. 459.—As to valves for freeing Keyham caisson from water, being no advance upon the practice of half a century back, 461.

Naval construction, &c. Water-tight

BERKLEY.

bulk-heads and other improvements suggested by Sir S. Bentham, iv. 180.

Benwell colliery, water pumped at, per day, ii. (1842) 171.

Bequest of Robert Stephenson, xix. 164.

BERGIN, —.

Railway, atmospheric, iii. 275.

BERKLEY, G. [Election, iv. 211.]

Locomotive engines, 'White Horse of Kent' class, viii. 257.—As to burning coal in, xix. 566.

Permanent way. Superiority of the contractors' form of rail over the bridge-rail, xvi. 381.—Iron permanent way, and as to adapting it to the increased weight and speed of engines and trains, xx. 285.

Railway, atmospheric. "The peculiar features of the atmospheric railway system," iv. 251.—Manner of making the experiments given in Mr. R. Stephenson's report on the, 272.

Railway traction, resistance to, experiments made on the Dalkey line, v. 288.

Railways, Indian, xix. 611.—Extent, character of the works upon, and cost of the East Indian railway, 611.—Rate of wages in Bengal before and after the mutiny, 612.—Cost of the Great Indian Peninsula railway, 612.—Locomotive engines employed upon it, 612.—Increase in the rate of wages in the Bombay Presidency, from 1853 to 1859, 612.—Salaries and wages of persons sent from this country, 613.—As to the Madras railway, and to the fact of the contract system not having been adopted in its construction, 614.—Average cost of railways in England, Scotland, and Ireland, compared with those constructed in India, 614.—Number of persons temporarily employed in the construction of Indian railways, and of those who would probably be permanently engaged, 615.—Beneficial effects of the introduction of railways into India, 615.—Passenger fares, and the receipts, both for passengers and goods, compared with the same in Great Britain, 616.—Future prospects of these enterprises, 617.

BERKLEY.

BERKLEY, J. J. [Election, xv. 47; Telford medal and Council premium, xx. 121, 170.]

Railways, Indian. "On Indian railways, with a description of the Great Indian Peninsula railway," xix. 586.

BERTHAM, T. H. [Election, vi. 134.]

Railway cuttings. Causes of slips in Acton and Sonning cuttings, Great Western railway (Colthurst, J.), iii. 166.

BESSEMER, H. [Telford medal, xix. 155, 193.]

Iron and steel. "On the manufacture of malleable iron and steel," xviii. 525.—Remarks, 548, 553.

BETHELL, J. [Election, i. (1838) 24; Auditor, ii. (1843) 67; iii. 65.]

Agriculture, use of chemical manures in, iii. 303.

Blasting under water. "On firing blasts under water by galvanism," i. (1838), 35. —, use of the voltaic battery for, xv. 335, 338, 344.—Failure in blowing up the docks of Sebastopol, 336.

Bude light, ii. (1843) 189, 190.

Coal-tar from gas-works, distillation of, xii. 228.

Lamp-burners, ventilation of, ii. (1843) 189.

Permanent way, construction of, in India, particularly as to the use of creosoted wooden sleepers, or of cast-iron sleepers, xviii. 429.—Durability of the creosoted sleepers laid on the Manchester and Crewe, the Eastern Counties, and the East Indian railways, 430.—Cost of the materials for the substructure of the permanent way of the East Indian railway, 431.—As to timber sleepers lasting longer in wet than in dry situations, 435.

Steam-engines, means of determining the horse-power of, x. 313.—Quantity of fuel consumed, a fallacious test, 314.—That a table, showing the power corresponding with a certain pressure, speed, length of stroke, and area of piston, would be advantageous, 315.

Timber, preservation of. Use of coal oil for preserving timber, and decay

BEUTH.

caused by ammonia, ii. (1842) 68.—The real inventor of the process of preserving brought forward by Dr. Boucherie, 88.—Process for saturating, with oil of tar, 88.—Strength of the solution for Kyanizing, used at Hull, 89.—Process for the introduction of silicate of potash into, 89.—Mode of creosoting, and on the result of its application at Lowestoft harbour, ix. 50.—Chemical effect produced on wood by the injection of soluble salts, 51.—Cost of creosoting, 57.—Assumed inflammability of creosoted timber, xi. 296.—Durability of creosoted sleepers, 296.—Kyan, Burnett, Margary, and Payne's processes, for preserving timber, xii. 223.—Process of creosoting 225, 234.—Average quantity of creosote absorbed by timber, 226.—Timber most suitable for creosoting, 226.—Manner of performing the process of creosoting, 227.—Comparative value of creosoted and Kyanized timber for marine works, xviii. 432.—As to creosoting timber, xix. 666.

Waves, depth to which the action of, extends, xix. 666.

Wrecks, recovery of property from submerged, xv. 330.—History of diving apparatus, 331.—As to his introduction, in 1835, of a tightly-closed dress, 332.—Instrument for discerning objects at the bottom of the sea, at a depth of from 50 feet to 100 feet, 333.—Great obstacle to the recovery of property from wrecks, 333.—Plan for repairing ships afloat, 334.—Use of his diving dress on board H.M.S. 'Thunder' and 'Wellesley,' 334.—Application of diving apparatus to engineering purposes, 334.—Method for raising wrecks, or heavy weights where there is no rise of tide, 337.

Béton (rubble), or concrete, employment of in works of engineering and architecture (Rennie, G.), xvi. 423.

BERR, E. L. [Election, viii. 310; Member of Council, xi. 84.]

BEUTH, P. K. W. [Memoir, xiv. 123.]

BEVAN.

BEVAN, W. [Election, ix. 232.]

BEYER, O. F. [Election, xiii. 364.]

Bickford's fuzes, i. (1838) 33; iv. 336; xv. 341.

BIDDELL, G. A. [Election, viii. 164.]

BIDDER, G. P., [Member of Council, vi. 46; vii. 56; viii. 44; ix. 91; x. 60; xi. 84; xii. 112; Vice-President, xiii. 123; xiv. 97; xv. 76; xvi. 88; xvii. 70; xviii. 164; President, xix. 132; xx. 108.]

Address, on taking the chair for the first time after his election as President, xix. 214.—Deaths of Mr. Brunel and of Mr. Robert Stephenson, 214.—Mr. Brunel's exertions in accelerating the progress of ocean steam navigation, 214.—Profession of the civil engineer, its scope and object, 218.—Present state of hydraulic engineering, 219.—Relative effects of tidal scour and of up-land waters upon rivers and harbours, 219.—The effects of the under-draining of land, 220.—As to the prospect of the sewage of towns being employed for the fertilisation of land, 220.—Offer of a premium for a Paper on the régime of rivers, 221.—Extension of submarine telegraphs, 221.—The national defences, especially in connection with the design and construction of steam ships, of rams, or vessels for running down, of harbours of refuge, of artillery, and of railway access to the coast, 222.—The points requiring investigation as regards rams, 223.—Harbours of refuge as bases of operations for the navy, and especially as to the principle of construction employed at Dover, Alderney, Jersey, Holyhead, and Portland, 225.—The progress of government works and those undertaken by private enterprise, contrasted, illustrated by reference to the New Westminster bridge, and the bridge over the river St. Lawrence at Montreal, 227.

Agriculture. As to the prospect of the sewage of towns being employed for the fertilisation of land, xix. 220.

Air, discharge of, into a partial vacuum, vi. 385, 386.

BIDDER.

Aqueducts. Bridge-aqueduct of Roquefavour, xiv. 208.

Artillery, construction of, xix. 338.—Tensile pressure evolved by the explosion of gunpowder, 338.—Whitworth and Enfield rifles, 400, 457.—Capability of vessels to resist great internal pressure, especially as to the construction of guns, 448.—Tensile force of metal, 448.—Armstrong and Whitworth breech-loading rifled ordnance, 448.—Cast-iron guns, 449.—Present practice of gunnery, 449.—Initial pressure of gunpowder, and its *modus operandi* upon the shot, 450.—Element of atmospheric resistance, 452.—Armstrong and Whitworth system of rifling, 453.—Ratio of the velocity of the retardation of the shot per element of distance, 454.—Results of experiments with spherical shot, with the Whitworth rifled cannon, and with the Armstrong gun, showing what has been accomplished by rifling, 454.—Comparison of the present results of the Whitworth and the Armstrong guns, 456.—Mode of breech-loading in the two guns, 456.—Experiments with Mr. Whitworth's rifled musket, 457.—The Emperor Napoleon III. on the "Past and Future of Artillery," 459.—Best kind of artillery for all uses, xx. 407.—Experiments upon iron plates, and upon a combination of iron and stone for embrasures, 424.—Initial velocity of the shot in the Armstrong artillery, 486.—Results of some comparative experiments made with Armstrong and with Whitworth 12-pounder guns at Shoeburyness, by the Ordnance Select Committee, 509.

Beacons, floating, construction of, xx. 312.

Beams, combination of iron and wood for, vi. 222.—Trials of beams for iron viaduct at Manchester, xi. 234, 236.

Boilers, as to preventing the incrustation of, and as to the presence of soda in water derived from wells under London, viii. 176.

Breakwaters, form and construction of,

BIDDER.

- xix. 607.—Breakwater at Alderney, 673.
- Bridges. construction of, v. 175.—Analogy between an arch of peculiar construction, and a bent trussed girder, 175, 176.
- Bridges. "Account of the cast-iron swing bridge over the river Wensum at Norwich," v. 434.—Remarks, 437.—Reliance to be placed in cast-iron piles, when driven into sound gravel, 438.
- Bridge over the Lee at Tottenham, on the line of the Northern and Eastern railway, vi. 220.—Torksey tubular bridge, ix. 246.—Relative areas of the top and bottom of the girders, 247.—Limiting the depth of girders, 247.—Small effect of vibration, 248.—Severe tests to which the bridge had been subjected, and its abundant strength for all purposes of traffic, 249.—As to the application of an empirical formula for ascertaining the strength of tubular girder-bridges, 275.—Advantages of the continuity of the girders, and on the effect of impact, 275.—Presumed economy of material afforded by lattice bridges, 358, 359.—Application of turn-table principle to swing bridges, xi. 425.—Comparative advantages of lattice and tubular bridges, 434.—Presumed economy of lattice sides over solid plate sides in girder bridges, xiv. 464.—Value and functions of vertical portion, or middle web of girders, 474.—Warren's girder, 475.—Trellis bridge, 476.—Relative weights of metal in Boyne lattice viaduct and Britannia tubular bridge, 476, 481.—Economy of materials in the sides of bridges, 482.—The progress of the now Westminster bridge and the bridge over the river St. Lawrence at Montreal, contrasted, xix. 227.—As to the cost of a bridge on the Mangaratiba Serra road, Brazil, 255, 261.
- Brunel, I. K., V.P., notice of the death of, xix. 214.
- Canals. As to endeavours to make a canal compete with a railway, xiii.

BIDDER.

- 210.—Use of steam power on canals, 212.
- Charts, as to contouring, so as to indicate the bottom of the sea, xx. 374.
- Civil engineer, progress of the profession of the, its scope and object, xix. 218.
- Coasts, &c. Accumulation of sand and shingle at Lowestoft, viii. 203.—Groynes on the Kentish coast, and on the south coast of Devon, 203.—Chesil bank, xii. 547.—Position of different sized pebbles on a beach, 548.
- Decimal coinage, &c. Best means of reducing the present coins, weights, and measures, to a good decimal system, with the least inconvenience, xiii. 347.—No necessity for basing the lineal standard of length, &c., on astronomical observations, 347.
- Defences, national, especially in connection with the design and construction of steam-ships, of rams, or vessels for running down, of harbours of refuge, of artillery, and of railway access to the coast, xix. 222.—The points requiring investigation as regards rams, 223.—Harbours of refuge as bases of operations for the navy, and especially as to the principle of construction employed at Dover, Alderney, Jersey, Holyhead, and Portland, 225.—As to the subject of the national defences being suitable for discussion at the Institution, xx. 403.—As to the "Report of the Commissioners, &c., on H.M. Naval Yards," 403, 515.—Absolute necessity of this country maintaining supremacy in the Channel, and how this was to be secured, 405.—As to the more prominent points touched upon in the discussion on the national defences, 506.—As to obtaining complete command of the Channel, 512.—Reasons given by the Defence Commissioners for fortifying Dover, and cost of the proposed defences, 514.
- Docks. Dock walls at Liverpool constructed of rubble, x. 239.—Sunderland docks, xv. 454.—Origin of the Victoria (London) docks, xviii. 482.—Land speculation forced upon the pro-

BIDDER.

motors' by the landowners, 483.—Important facilities presented by the project, 484.—System of cast-iron wharfing, 484.—Failure of the side-walls of the lock-chamber, 484.—Source of the water found in the vaults of the jetties, 485.—Application of hydraulic power in docks, 485.—Construction of the jetties, 486.—Material for lock-gates, 486.—Improvements which suggested themselves during the progress of the works, 487.—Cost of the several works, 487.—Cost of the wrought-iron gates, 488.—Tyne docks, their situation, and possible effect upon the régime of the river Tyne, 520, 524.

Drainage of land. Arterial drainage-works in Ireland, xix. 105.—Effect of the Eau-Brink works, 105.—Effect of under-drainage on the supply of water to rivers and streams, 105, 220.—Depth to which under-drainage should be carried, 125.—Government interference with the drainage of land, 128.—Extract from a pamphlet by Edmund Burke as to the duties of the State, 129.—Deep drainage, xx. 256.—Question of outfall, 257.

Drainage of towns, and use of earthenware pipe-drains, or of brick sewers, xii. 88.—Proposals for utilising the sewage matter of the metropolis, 89.—Mr. Wicksteed's plan for separating the fertilising matter in a solid state, from the sewage water, 89.—Sewerage of Hamburg, xiii. 78.—Drainage of the district south of the Thames, 108.—Argument in favour of pumping the sewage into the country in a liquid form, 109.—Prospect of the sewage of towns being employed for the fertilisation of land, xix. 220.—Pollution of the river Wandle by the drainage of Croydon being carried into it, xx. 209.

Electric telegraph, first adoption of, on Blackwall railway, and subsequently on Norfolk railway, xi. 373.—Reasons why overground, or suspended system of wires was decided upon, 373.—Electric telegraph instruments, 374.—Statistics of telegraphic communica-

BIDDER.

tion from central office of the Electric Telegraph Company, 374.—Cost of two systems of laying telegraph wires, 378.—Engineering works, ancient and modern, contrasted, xiv. 209.

Ericsson's caloric engine, action of 'regenerator' in, xii. 347, 350.

Fire-proof buildings, especially in relation to the question of insurance, viii. 157, 159.

Fluids, elastic, expansion of air and steam, vi. 339, 341.—Discharge of, under-pressure, 339.

Fluids, resistance to bodies moving in, v. 275.—Causes producing the resistance, 275.—Various methods of experimenting on ditto, 276.—Resistance offered by paddle-floats, when dragged through the water, 277.—Relation between the velocity and the resistance, 278.—Ascertaining ditto, by means of the indicator attached to the engines of the vessel experimented on, 280.

Foundations. Foundation of a bridge at Reedham, on the Lowestoft branch of the Norfolk railway, vi. 157.—Artificial foundations, and means adopted for carrying the permanent way of the Norfolk railway over a morass, 158.

Fuel, best method of employing the products of combustion of, with least waste, xi. 406.—Consumption of, and amount of water converted into steam, relatively to the work performed, xv. 373.

Girders. Relative advantages of the Warren girder and girders constructed on other principles, xii. 608.

Government works, the progress of, and those undertaken by private enterprise contrasted, illustrated by reference to the New Westminster bridge, and the bridge over the river St. Lawrence at Montreal, xix. 227.

Harbours. Effect of the wave trap at Sunderland, viii. 203.—Conditions under which a harbour can be maintained where there is a travelling beach, xii. 548.—Works at Lowestoft cited in illustration, 548.—Selection of sites for, xv. 453.—Bars at the mouths

BIDDER.

of harbours cannot be entirely prevented, 454.—The great problem in sluicing is the maintenance of a strong uniform current, 454.

Harbours of refuge, form and construction of breakwaters applicable to, xviii. 122.—Admiralty Pier at Dover, 124.—Portland breakwater, 125.—Alderney and Jersey, 127.—Holyhead, 127.—Constitution of Government Commissions to inquire into the subject of, 127.—Works for, authorised by Government, and breakwater at Portland, 129.—Principle of construction employed at Dover, Alderney, Jersey, Holyhead, and Portland. xix. 225.

Hydraulic engineering, present state of, xix. 219.

Labour, free and slave, relative value of, xix. 262.

Looke, J., M.P., Past President, notice of the death of, xx. 1.

Lock-gates, material for, xviii. 486.

Locomotive engines. The steadiness of locomotive engines dependent on the driving-wheels being placed behind the fire-box, and the weight being comprehended between the extreme wheels, viii. 250.—Long-boiler engines, 256.—Comparative advantages of large and small wheels for locomotives, 258.—Evaporation of water under the boiler of a goods engine, xi. 406.—Actual working results of, compared with deductions from Mr. D. K. Clark's formula, xii. 420, 427.—No advantages result from the extension of the fire-box, and the reduction of the length of the tubes, 422.—Requisites for the best form of locomotive engine boilers, 422.—Circumstances which must determine the use of coal, or coke, on railways, xvi. 36.—Mr. Beattie's coal-burning locomotive engine, 36.—Advantages resulting from the correct equilibration of the locomotive engines on the Eastern Counties railway, 36.

London time, general adoption of, throughout the country, iv. 75.

Marine engines, asserted increase in the

BIDDER.

expenditure of fuel, when working steam expansively, xvi. 369.

Materials to be employed in tropical countries, xix. 262.

Mental calculation. "On mental calculation," xv. 251.—Chronological experience as a mental computator, 257.

Naval construction, &c. State of ship-building in the public establishments, xix. 460.—Vessels to be employed for naval service, xx. 406.—Plating vessels with iron, for resisting shot, 406.—Way in which the future navy of this country should be constructed and maintained, 407.—As to the "Report of the Commissioners, &c. on H. M. Naval Yards," particularly as to the construction of the navy, and the management of the accounts, 515.—Cost at which an efficient navy could be maintained, deduced from the experience of the Peninsular and Oriental Steam Navigation Company, 517.—What should be the class and mode of construction of the ships of the Royal Navy, 518.—Steam rams, and the opinions of Captain Sullivan on the subject, 520.

North Sea viewed commercially, geographically, and physically, xx. 335.—Variation in the range of the tides, and as to the currents on the Danish and Norwegian coasts, 335.—Dogger Bank, 336.—Propagation of the tidal wave through the Straits of Dover into the North Sea, 344.—Tidal and other phenomena of the North Sea, the extent of the fisheries, and the currents over the Dogger Bank, 371.—Baltic Sea, 372.—Necessity for harbours of refuge in the North Sea, 374.

Permanent way, particularly of the London and Blackwall, and Northern and Eastern railways, v. 244.—Method of constructing permanent way in the United States, vi. 79.—Durability of creosoted fir-sleepers, viii. 269.—Construction and maintenance of permanent way, xi. 292.—Rail first laid on Blackwall railway, 293.—Best system of per-

BIDDER.

manent way, 293.—Ditto of repairing an existing road, 294.—Railway sleepers, and means for preserving them, xii. 241.—Necessity of employing best materials for rails, joints, and crossings, xiv. 437.—Permanent way in Norway, Canada, and Denmark, xvi. 287, 385.—As to concentrating all inventions for permanent way into the hands of one company, 287.—As to the statement that Burnettized sleepers had been used on the Northern and Eastern railway, xviii. 434.—Principle which should be adopted for the permanent way of railways in India, 434.—Iron permanent way, xx. 289.

Pier at Southport, Lancashire, xx. 299.

Power, cost of different means of producing, xvi. 413.

Railway, atmospheric. Speed to be attained by means of the atmospheric system, iv. 264.—Comparison between the locomotive and atmospheric systems of traction, 286.

Railway breaks on the London and Blackwall railway, v. 158.—Experiments upon breaks, and objects of, xix. 525.

Railway companies. How far railway companies can, with economy, become manufacturers, xl. 469.—Economies which might be effected by, 470.

Railway ferries. Floating railways at the Forth and Tay Ferries, xx. 389.

Railway inclines. Plan of working the Giovi and Semmering inclines, xv. 372.

Railway trains, resistances to, Mr. D. Gooch's letter on some experiments, for determining the, v. 417.—Experiments tried on the Great Western railway, and on the applicability of the atmospheric system for trying similar experiments, 421, 425.—Experiments made on the atmospheric system, 426.—Comparison between the results shown in an experiment made by Mr. Harding, and, by Mr. Gooch's diagram, 429.—Mode of conducting experiments for ascertaining the, vii. 302, 307, 308, 321.—Experiments on inclined planes, 312.

BIDDER.

Railways. Ropes used on the London and Blackwall railway, v. 156.—Breaks employed on ditto, 158.—Traffic on ditto, 158.—Construction of railways abroad, particularly as to the terms of the concessions obtained in Norway and in Denmark, xviii. 22.—As to Parliament sanctioning the levying of rates, for the guarantee of capital invested in railways, 44.—Comparison between the railway systems of England, Ireland, and France, 44.—Circumstances under which steep inclines could with propriety be adopted on railways, 69.—Relative value of free and slave labour, materials to be employed in tropical countries, and prosecution of railways under guarantee, xix. 262.—Indian railways, 623.—Present speed of travelling on railways, xx. 231.

River Orwell, and the port of Ipswich, xx. 24.

— Severn, works on the, at the Upper Lode, near Tewkesbury, xix. 544.

— Thames, past and present condition of the, xv. 236.—Effect of Government interference with public works, 237.—Sewerage of the metropolis, 238.—Probable effect of proposed construction of a dam with sluices and works at London bridge, 238.—Exhalation of noxious gases from sewage in the natural harbour or 'Fiord' at Christiania referred to in illustration, 239.

— Wandle, particularly as to the sinking of a well at Croydon by the Local Board of Health, the pollution of the river by the drainage of Croydon being carried into it, and the flow of water in the river, xx. 209.

— Wear, mode of testing the deposits in the, vi. 282.

Rivers and estuaries. Possible effect of the Tyne docks upon the régime of the river Tyne, xviii. 520, 524.—Crossing of Breydon Water, by the railway from Yarmouth to Norwich, and the works imposed

BIDDER.

upon the railway company by the Admiralty authorities, 521.—Necessity for a complete record of the phenomena attending works for the improvement of rivers, xix. 105.—Effect of the Eau-Brink works, 105.—Effect of under-drainage on the supply of water to rivers and streams, 105.—Ditto of upland and tidal water on the scour of rivers, especially as to the case of the river Thames, 127.—Relative effects of tidal scour and of upland waters upon, 219; xx. 24.—Offer of a premium for a Paper on 'the régime of rivers,' xix. 221.—Pollution of rivers, by the discharge into them of town sewage, xx. 255.—Proportion of the rainfall flowing off by means of rivers, 256.

Roofs, calculating weight of, xiv. 270.

Ruthven's propeller, system of propulsion, somewhat similar to, tried by Mr. Bidder, xiii. 374.

Sea defences, construction of, vi. 181.

Steam. As to the rationale of the advantages derived from superheating, xix. 487.—Use of combined steam, 487.

Steam navigation, &c. Supposed wave-pressure of 40,000 tons of water upon the 'Great Eastern,' xiii. 47.—Misconception in confounding the wave of oscillation, with that of translation, 47.—Proper proportions of length to breadth for steam-ships, 47.—Causes of casualty to the 'Wave Queen,' off Newhaven harbour, 48.—Argument based upon speed and other properties of H.M.S. 'Battler,' must be fallacious, 49.—Great raft ship, the 'Baron of Renfrew,' 55.—Measurement of ships for tonnage, 63.—To what extent can steam-power be economically substituted for the natural power of the air in the transit of coals, xiv. 367.—Application of auxiliary steam-power to sailing-vessels, 390, 416.—Mr. Brunel's exertions in accelerating the progress of ocean steam navigation, xix. 274.

Stephenson, R., M.P., Past-President: notice of the death of, xix. 214, 216.

Telegraph cables. Want of information

BIDDER.

as to the means intended to be adopted in laying the proposed Atlantic telegraph cable, and as to the strain to which it will be subject, xvi. 218.—Submerging telegraph cables, particularly the Atlantic cable, xvii. 332, 364.—Loss, or waste of cable in paying out, 333.—Strain on the cable in paying out, 333.—Extension of submarine telegraphic communication, xix. 221.—Submarine telegraph cables, xx. 52.—Telegraphic communication with India, 65.—Accident to a cable belonging to the Electric and International Telegraph Company, 66, 104.—Present state of submarine telegraphy, 95.—Failure of the Atlantic telegraph, 96.—Red Sea telegraph, 97.—History of the Red Sea line, as given in the Parliamentary papers, 97.—Rangoon (Malta—Alexandria) cable, 103.—Proper steps for insuring satisfactory submarine telegraphic communication, 104.

Timber, Payne's process for preserving, ix. 56.—Protection of, from the worm, xii. 241.—Ravages of the worm at Lowestoft harbour, xviii. 433.

Tunnels. Construction and enlargement of the Lindal tunnel, xix. 239.—Construction of tunnels, for railways and canals, 281.—Netherton tunnel on the Birmingham canal, 281.

Viaducts. Accident to the Congleton viaduct, on the North Staffordshire railway, during its construction, x. 239.—Cost of railway viaducts, xiv. 209.

Water, flow of, through pipes. Published results of some experiments, made under the direction of an engineer to the Board of Health, on the flow of water through a pipe at Alnwick, xiii. 115.—Flow of water through pipes, xiv. 288.—Tendency on part of public boards to invalidate established formulæ, 289.—Flow of water through different sizes and qualities of tubes, 311.

Water, resistance to bodies moving in, and particularly that due to the fric-

BIDDER.

- tion of the immersed surfaces, xvi. 342, 368.
- Waves, effects of the action of, vi. 131.
- Weirs, oblique, practical limit to the advantages of, v. 356, 357, 360.
- Wharfing, cast-iron, adopted at the Victoria (London) docks, xviii. 482.
- Wrecks. As to clearing away the wreck of the 'Boyne,' xv. 330.
- BIDDER, G. P., Jun.**
- Defences, national. "The National Defences," xx. 391.—Remarks, 408.—Sum voted for coast defences, 502.—Protection of the ports of the kingdom not dependent upon the Channel fleet, 503.—As to spending money upon isolated land-forts, 503.—Importance of utilising those materials and resources which the country possesses in abundance, and economising those which are given more sparingly, 505.
- Naval construction, &c. Iron plating of vessels, xx. 504.—Advantage of constructing ships with one deck, 504.
- Bilge-water of vessels destroys copper pipes; stout lead pipes recommended instead, ii. (1842) 154.
- BINGHAM, H. C.** [Election, i. (1839) 63.]
- BIRNS, W.** [Election, xvi. 226.]
- Biram's anemometer, for mining purposes, and also his miner's lamp, viii. 137.
- BIRCH, E.** [Election, i. (1839) 42; Telford medal and premium, i. (1839) 6; Premium, i. (1841) 10.]
- Machinery. "On Huddart's rope machinery," i. (1838) 39.
- "Description of a machine for sewing flat ropes," i. (1841) 171.
- BIRCH, J. B.** [Election, i. (1840) 41; Walker premium, ii. (1842) 9; Walker premium, ii. (1843) 7.]
- Bridge, Kingston. "An account of the bridge over the Thames, at Kingston, Surrey," ii. (1842) 184.
- Machinery. "Description of Stephenson's theatre machinery," i. (1841) 153.
- BIRD, W.** [Election, x. 244; Member of Council, xix. 132.]
- Iron, cheap Scotch, xii. 378.

BLAKELY.

- Permanent way. 'Fishing-plates' used on German railways, xi. 277.
- Bird's tumbler lock, xiii. 256.
- BIRKBECK, G. H.** [Election, ii. (1843) 105.]
- BIRKINSHAW, J. C.** [Election, vi. 134.]
- Birmingham and Gloucester railway, (Jackson, G. B. W.) ii. (1842) 53.
- BISHOPP, G. D.** [Walker premium, iii. 7.]
- Locomotive-engines. "Description of the American engine 'Philadelphia,' made by Mr. Norris, of Philadelphia, North America, for the Birmingham and Gloucester railway," ii. (1843) 99.
- BIVEN, E. J.** [Election, i. (1841) 83; resignation, x. 72.]
- BLACK, Dr.**
- Junction of the Atlantic and Pacific oceans. Surveys of the valley of the Atrato, by Messrs. Trautwine, Porter, Lane, and Captain Kennish, to ascertain the practicability of a ship canal, without locks, in that direction, for effecting a junction between the Atlantic and Pacific oceans, xv. 400.—Climate of the Atrato valley, 401.
- BLACKADDER, W.** [Memoir, xx. 136.]
- BLACKBURN, J. T.** [Election, iii. 66; resignation, viii. 9.]
- BLACKBURN, J. G.** [Election, xiv. 491.]
- Blackwall railway, ii. (1843) 70; v. 143.
- BLACKWELL, —.** [Memoir, ii. (1842) 13.]
- BLACKWELL, —.**
- Iron, manufacture of, xii. 376.
- BLACKWELL, T. E.** [Election, ii. (1843) 68; Council premium, xi. 87, 118.]
- Rivers and estuaries. Difference in physical conditions of tidal rivers, xii. 14.
- Treatment of rivers, 14.
- Water, discharge of. "Results of a series of experiments on the discharge of water by overfalls, or weirs," x. 331.
- Remarks, 350.
- BLAKE, Professor.**
- Gold. Extract from his description of the gold regions of California (Hopkins, E.), xv. 71.
- BLAKE, H. W.** [Election, iv. 372.]
- BLAKELY, Captain, R.A.**
- Artillery. Extract from his specification for a method of making guns, by the

BLAKELY.

application of rings shrunk on an inner tube (Longridge, J. A.), xix. 303.—His experiments with an 18-pounder constructed on this plan, and with a 9-pounder turned down and strengthened from the trunnions to the breech on the same system, 304.

Artillery. Construction of artillery, particularly as to building up a gun of concentric cylinders, xix. 348.—Experiments with guns made on his system, 348.—Gun cast on a hollow core by Lieutenant Rodman, 371.

Blakely's (Captain) gun, xx. 501.

BLAKISTON, M. [Election, xv. 281.]

BLANCHARD, —.

Timber, his method of bending, (Molesworth, G. L.), xvii. 36.

BLASHFIELD, J. M.

Brickmaking. Prosser's method of dry moulding, ii. (1843) 149, 152.

Blast-engine, experiments upon the pumping of blast for furnaces, iii. 247.

Blast-furnaces. *Vide* FURNACES.

BLASTING.

Gun-cotton applicable to, (Rennie, Sir J.), vi. 26.

Limestone. "Account of some blasting operations through the white limestone on the Antrim coast road, in the north of Ireland." By W. Bald, i. (1837) 40.—Quantity of gunpowder used, 42.

— "Further observations on blasting the white limestone of the Antrim coast." By W. Bald, i. (1837) 41.

— "On the limestone, the lime cement, and method of blasting in the neighbourhood of Plymouth." By W. Stuart, i. (1838) 35.

Round Down Cliff, South-Eastern railway, by electricity, (Rennie, Sir J.), v. 105.

Sandstone. Expenditure of labour and gunpowder per cubic yard (Lane, C. B.), xi. 74.

BLASTING under water.

Bickford's fuzes. "On the application of Bickford's fuzes to blasting under water." By Lieut.-Gen. Sir C. W. Paaley, i. (1838) 33.

BLASTING.

Discussion.—Macneill, Sir J., 34.—Paaley, Lieut.-Gen. Sir C. W., 34.—Rendel, J. M., 34.

Bickford's fuzes, (Paaley, Sir C. W.), xv. 341.

Harbour, West Hartlepool. "Description of a raft, or float, used for submarine blasting, on the works of the West Hartlepool harbour and docks." By T. Casebourne, x. 293.

Discussion.—Clark, T., 295.—Cubitt, Sir W., 295.—Highton, E., 295.—Jackson, R. W., 295.—Simpson, J., 295.

River Jumna. "On some operations in blasting in the Jumna, and at Delhi." By Lieut. G. Tremenheere, B.E., i. (1838) 37.

— Severn. "The application of gunpowder as an instrument of engineering operations, exemplified by its use in blasting marl rocks in the river Severn." By G. Edwards, iv. 361.—Description of the improvements proposed, 361.—Extent and nature of the shoals, 362.—Attempts to remove them by the dredging machine and 'subsoil' plough, 363.—Application of gunpowder for blasting the marl shoals previous to using the dredging machine, 363.—Description of the preparations and materials, 363.—Ditto of the method pursued, 364.—Use of Bickford's fuze for igniting the powder, 366.—Comparison between the effect of the fuze and the galvanic battery, and their relative cost, 368.—Details of the cost and the amount of labour, 369.

Discussion.—Edwards, G., 370.—Giles, F., 370.—Grissell, T., 371.—Paaley, Lieut.-Gen. Sir C. W., 371.—Rennie, Sir J., 371.

Sebastopol, failure in blowing up the docks of, (Bethell, J.), xv. 336.

Voltaic battery. "On firing blasts under water by galvanism." By J. Bethell, i. (1838) 35.

— "Account of the firing of gunpowder under water by the voltaic battery, at Obatham, March 16, 1839, under the direction of Col. Paaley."

BLECHINGLEY.

- By F. Bramah, Jun., and C. Manby, i. (1839) 50.
- Voltaic Battery.** (Bethell, J.), xv. 335, 338, 344; (Pasley, Sir C. W.), 337, 340; (Belcher, Sir E.), 339; (Vignoles, C.), 339; (Pearsall, T. J.), 339; (Mallet, R.), 339; (Stephenson, R.), 340.
- Wreck of 'Royal George,'** electricity first effectively applied to the, (Rennie, Sir J.), v. 104.
- Blechingley tunnel, brickmaking at,** (Simms, F. W.), ii. (1843) 145.
- Blenkinsop's locomotive engine,** v. 70.
- Blood, action of carbonic acid upon the circulation of the,** ii. (1843) 190, 191.—**Opinions of Hall, Davy, Graham, and Edwards,** 190, 191.
- BLOOD, W. B. and DOYNE, W. T.**
Lattice beams. "An investigation of the strains upon the diagonals of lattice beams, with the resulting formulæ," xi. 1.
- BLUNT, —.**
Surveying signals employed in America, i. (1837) 19.
Steamers, American, i. (1837) 21.
- BLYTH, B. H.** [Election, iii. 66.]
- BLYTH, E. L. I.** [Election, xviii. 296.]
Permanent way. Larch preferable to Scotch fir, creosoted, for sleepers, xviii. 436.
- Board of Health, General, experiments by, for determining transmission of water through sewers,** xi. 417.
- Board of Works, Ireland, delays arising to public works, from scrutiny of,** xi. 427.
- BOATS.**
Canal boats, experiments on, (Palmer, H. R.), ii. (1843) 114.—**Iron,** (Rendel, J. M.), 178.—**Fast,** (Rennie, Sir J.), v. 77.
Iron. "Description of the 'Nonsuch' iron passage boat plying on the Limerick navigation, between that place and Killaloe." By C. W. Williams, i. (1840) 28.
Discussion.—Field, J., 29.—Parkes, J., 29.
Lowering, Clifford's system of, xiv. 418.
Steering, apparatus for. "Description of a new mode of steering, as applied to boats of light draught of water,

BORING.

- navigating shallow and rapid rivers." By Capt. Henderson, i. (1841) 80.
- BODMER, J. G.** [Premium, v. 2.]
- Fuel.** "On the combustion of fuel in furnaces and steam boilers, with a description of Bodmer's fire grate," v. 362.—**Remarks,** 368.—**Means of regulating the amount of air admitted to the fire grate,** 368.
- Steam-engines.** "The advantages of working stationary and marine engines with high-pressure steam, expansively and at great velocities, and of the compensating or double-crank system," iv. 372.—**Description of a pair of 300 H.P. marine engines constructed on his compensating principle,** 394.—**Description of a 200 H.P. stationary engine on ditto, and furnished with the variable expansion gear,** 396.
- Bog, formation of foundations on,** vi. 152, 158.—**Rising of ditto,** 154.
- 'Bogie' engine,** ii. (1843) 99.
- BOILEAU, General.**
Foundations, construction of, in India by means of wells, xvii. 531.
Public works in India, their execution by military officers, and the difficulties which had to be contended with, xvii. 530.—**Materials used in the public works of Bengal,** 531.
- BOILERS. Vide LOCOMOTIVE BOILERS, and STEAM BOILERS.**
- Bombay, population of, preponderance of trade to, and exports and imports,** xix. 590.
- BONNIN, J.**
Breakwater, Cherbourg, (Manby, C.), xvi. 445.
Concrete blocks, construction and employment of, (Manby, C.), xvi. 445.
- BOOKER-BLAKEMORE, T. W.** [Election, x. 57; memoir, xviii. 202.]
- BOOKER, J.** [Resignation, xi. 93.]
- Boring for water through granite,** i. (1839) 44.
- Boring machine, earth, Messrs. Mather and Platt's,** xiv. 523.
- **wells, description of an apparatus for, (Mitchell, —, Jun.),** i. (1837) 18.

BORRODAILE.

Borrodaile's felt for inner sheathing, ii. (1842) 170.

BORTHWICK, M. A. [Telford medal, i. (1838) 8; memoir, xvi. 108.]

Dymchurch wall, vii. 195.

Embankments, slipping of, on the Ely and Peterborough railway, vi. 158.

Foundations, artificial, on bog, vi. 158.

Lighthouses. First lighthouse-tower proposed to be of cast-iron, ix. 189.

BOSWALL, Captain J. D., R.N. [Election, iv. 372.]

BOTTFIELD, B. [Election, i. (1840) 54.]

BOTT, W. E. [Election, viii. 261.]

Botto's (Prof.) electro-magnetic engine, xvi. 389.

BOUCH, T. [Election, x. 57.]

Railway ferries. Floating-railways across the Forth and Tay ferries, xx. 385, 387, 389.

BOUCHERIE, Dr.

Timber, his process for preserving, by aspiration of metallic salts (Taylor, J.), ii. (1842) 87.—Identical with Bethell's invention, patented two years previously (Bethell, J.), 88.

Boulton and Watt's valves, iii. 94.

BOULTON, S. B. [Election, xvi. 46.]

BOURDON, E. [Telford medal, xii. 116.]

Manometer. "Description of a new metallic manometer, and other instruments for measuring pressures and temperatures, xi. 14.

BOURNS, C. [Telford medal and premium, i. (1841) 9; resignation, xi. 93.]

Gradients. "Table of gradients," i. (1838) 49.

Railway curves. "On setting out railway curves," i. (1840) 56.

BOUSTEAD, J. [Election, i. (1841) 157.]

Roofs. "Description of the roof of Messrs. Simpson and Co.'s factory," ii. (1842) 91.

BOUITIGNY (d'Evreux) P. H. [Election, xii. 109; Telford medal, xii. 116; resignation, xvii. 8.]

Steam boilers. "Description of a diaphragm steam generator," xi. 392.—Remarks, 398.—Result of work of one of the diaphragm steam generators, 404.

BRAIDWOOD.

Timber, decay of, and means of preventing it, xii. 239.

Water, quotation from his opinion as to spheroidal state of, at high temperatures (Woodcock, W.), xv. 288.

Bowcombe creek drawbridge near Kingsbridge, Devon, (Dobson, G. C.), ii. (1843) 68.

BOXER, Captain, R.A.

Artillery, construction of, xix. 368.—

Ordnance Select Committee, 369.—

Cast iron as a material for guns, 370.

Gunpowder, strength of, xix. 369.

Box-tunnel incline, expense of working, ii. (1843) 103.

BOYD, J. [Election, xii. 109.]

BOYLE, R. V. [Election, xiii. 190.]

Defence of Arrah by him, noticed in Annual Report, xviii. 165.

Boyne lattice viaduct, weight of, compared with Britannia tubular bridge, xiv. 465, 476, 481, 488.

Bracing in the Maplin Sand and the Port Fleetwood lighthouses, ii. (1842) 151.

BRADSHAW, G. [Election, ii. (1842) 56; memoir, xiii. 145.]

BRAIDWOOD, J. [Telford medal, iv. 3.]

Fire-proof buildings. "On fire-proof buildings," viii. 141.—Remarks, 147.—

Fire-proof safes, 147.—Thin plate-iron on walls does not arrest the progress of fire, 148.—Inability of warehouses built on the usual fire-proof principle, with iron columns and girders and brick arches, to resist the action of fire, 153.—Construction of the stairs of dwelling-houses, 154.—Strength of cast iron diminishes as the temperature is raised, 156, 162.—Proper system to be adopted in building warehouses and fire-proof dwelling-houses, 157.

—, construction of, xii. 266.

Fires, means of extinguishing. "On the means of rendering large supplies of water available in cases of fire; and on the application of manual power to the working of fire-engines," iii. 309.—Remarks, 328.

— Superiority of water over chemical means, for extinguishing fires, viii. 160.

BRAITHWAITE.

- Braithwaite and Ericsson's locomotive engine, the 'Novelty,' v. 7.
- BRAITHWAITE, F. [Election, i. (1838) 46; Member of Council, ii. (1842) 51; (1843) 67; iii. 66; Council premium, xv. 81, 104.]
- Boilers. Explanation of Dr. Clark's mode of purifying water, to prevent the incrustation of steam boilers, v. 204. —Experiment in illustration, 205.
- Brickmaking, ii. (1843) 152.
- Drainage of land, xx. 210.
- Ericsson's caloric engine, first trials of, in England, xii. 351.
- Iron, manufacture of, iii. 245.
- Isthmus of Suez, x. 379.
- Locomotive engines, American, ii. (1843) 102.—Use of coal in locomotive engines, xvi. 28.
- London basin. Drainage and replenishment of the chalk basin of London, ii. (1843) 164.—As to the lowering of the level of the water in the London basin, and the infiltration of salt water into wells under London, viii. 178.—Geological features of the London basin, ix. 165.
- Machinery, composition of bearings for, iii. 88.
- Marine engines. Means of disconnecting the engines from the screw, or paddle-wheels of steam-vessels, iv. 176.—Causes of accidents to the main shafts of marine engines, xiii. 468.
- Meat, preservation of, by Payne and Elmore's process, ii. (1842) 83.
- Metals. "On the fatigue and consequent fracture of metals," xiii. 463.—Remarks, 467, 468, 472, 473.
- Mines, ventilation of, vi. 204.
- Patent laws, unsatisfactory state of the, x. 216.
- Permanent way. Compressed keys and their cost, iv. 56.
- Railway, atmospheric, divisor for calculating the H.P. of the engines on the, iii. 282, 283.—Atmospheric system, iv. 279.
- Railway cuttings, iii. 147.—Slips, 169.
- Railway trains, resistances to. Atmospheric resistance to railway trains, v.

BRAITHWAITE.

- 422.—As to proposed experiments on the Epsom line (atmospheric), 427.—Mode of conducting experiments for ascertaining the, vii. 324.
- River Wandle. "On the rise and fall of the river Wandle; its springs, tributaries, and pollution," xx. 191.—Remarks, 210, 231.
- Rivers, source of, xx. 18.—Supply of water for, 210.—Laws of absorption and of evaporation, 231.
- Roofs, arched, ii. (1842) 145.
- Screw-propellers, iii. 83.
- Sewage of towns. Objections advanced against the commercial application of sewage manure, vii. 101.—Practicability, in a commercial point of view, of utilising the sewage water of London, 102.
- Smoke, prevention of, in engine-furnaces, xiii. 405.
- Telegraph cable, Tasmanian, xx. 75.
- Timber, absorption of water by, under pressure, ii. (1842) 86.—Instance of the durability of a timber ship, ii. (1843) 180.
- Wells. Sinking and boring into the chalk, ii. (1842) 162.—Ditto with lateral driftways, at Messrs. Reid's brewery, 164.—Difference between the method employed in sinking the well for Messrs. Truman and Co., and that for Messrs. Reid and Co., ii. (1843) 57, 58.—Use of the miser, 59.—Filtration, 138.—Temperature of the water in wells, 141.—Well at Southampton, 142.—Well at Cheshunt, and the influence of local circumstances on temperature, 143.—Sinking metal cylinders, iv. 249.—On some deep wells in and about London, and the analyses of waters obtained from the well of the Royal Hospital, Greenwich, v. 203.—Ditto from the well at Mr. Page's brewery, Greenwich, 203, 204.—Ditto from the well at Lambert's brewery, 204.—Exhibition and description of a chart, upon a large scale, showing the positions of the principal deep wells of the metropolis, 478.—As to the lowering of the level of the water in the London basin,

BRAITHWAITE.

and the infiltration of salt water into wells under London, viii. 178.—Well at Messrs. Reid and Co.'s brewery, 185.—Depression of the water of the sand-spring at Messrs. Combe's brewery, ix. 165.—Table of ditto, from 1837-49, 166.—Geological features of the London basin, 165.—Whether the supply of water to wells is derived from the chalk, or from sand-springs, 167.—Tidal wells, and on the water of deep springs becoming saline, 168.—Analyses of seventeen samples of water from wells in and around London, 176.—Table of ditto, 177.—Experiments made on chalk taken from a well 204 feet in depth, 369.—Difficulty of sinking in sand, xiii. 477.—Definition of term, 'water-bearing stratum,' xiv. 66, 73.—Depression of water-level in chalk, 76.—Faults and disturbances in chalk basin, 74.—Well at Hampstead for the water-works, 74.

— "On the infiltration of salt water into the springs of wells under London and Liverpool," xiv. 507.—Remarks, 520.—Quantity of water to be obtained from wells under London and Liverpool, 512.—Quality of ditto, 514.—Cause of presence of soda-salts in ditto, 515.—Analysis of water in Trafalgar-square well, 519.—Increase in soda-salts in Liverpool water, 522.

— Deep wells of the metropolis, the gradual depression of the level of the water in them, and the rainfall and evaporation in the London basin, xix. 33.—Analyses of water from wells on the north side of London, and from that at Plumstead, 37.—Quantity of water that could be abstracted from the deep wells under London, more particularly on the north side, 43.—Well at Trafalgar-square, and analyses of the water from it, as well as from the chalk at Tring and Watford, 43.—Level of the water in Combe and Co.'s well, and in that in Orange-street, 44.

BRAITHWAITE, J. [Election, i. (1838) 9.]
Wells. Report on the state of Messrs.

BRAMWELL.

Truman's well (Davison, R.), ii. (1842) 193.

BRAMAH, F. [Member of Council, i. (1837) 15; (1838) 20; (1839) 27; (1840) 36; Telford medal, i. (1839) 8; memoir, i. (1841) 14.]

Beams. "A series of experiments on the elastic weight and strength of cast-iron beams," i. (1837) 45.

Cements, various kinds of, i. (1837) 20.

Fuel, use of peat for, i. (1839) 30.

Materials, strength of, i. (1837) 29.

BRAMAH, F., Jun. [Auditor, i. (1841) 52; memoir, ii. (1842) 13.]

— and MANBY, C.

Blasting under water. "Account of the firing of gunpowder under water by the voltaic battery, at Chatham, March 16, 1833, under the direction of Colonel Pasley, i. (1839) 50.

Bramah's (J.) numbering press for bank notes, ii. (1842) 166.—Hydrostatic presses, iii. 304.—Lock, patented in 1784, xiii. 255.—Water-meter, xvi. 59.

BRAMWELL, F. J. [Election, xv. 418.]

Artillery. Method of casting ordnance in the United States, xviii. 341.—Objections to casting guns solid, xix. 363.—Principle, introduced into the American service by Lieutenant Rodman, of casting guns hollow, 363.—Result of comparative experiments with a solid and with a hollow gun, 363.—Area of the section of the gun which bears the strain, 365.

Bells at the New Palace, Westminster, composition of the metal of the, xix. 15.

Engines. Performances of Du Trembley's combined vapour engine, compared with the performances of ordinary marine steam engines, xviii. 260.—Ditto with the most economical engines working on land, 262.—Ditto with a theoretically perfect engine, 262.—Question of the leakage of the ether in Du Trembley's engine, 263.—Economy of Du Trembley's system, 264.—Why it has not been carried out in England, 264.—Use of other fluids than ether, 265.—Plan adopted for

BRANDE.

- fixing a brazed tube to the tube-plate, 265.—Hydraulic packing, 266.
- Hydraulic apparatus at the Victoria (London) docks, xviii. 481.
- Iron and steel, Bessemer process for the manufacture of malleable, xviii. 547.
- Marine engines. Results of working steam expansively in, xvi. 861.
- Metals. Effect upon a metal of a quiescent load, xviii. 339.—Mode of producing Stirling's metal, by mixing wrought and cast iron, 860.
- Railway breaks, xix. 519.
- Water, friction of vessels passing through, xvi. 361.
- BRANDE, Professor.**
- Gas. Extract from his report to the Chartered Gas Company (Lowe, G.), iii. 301.
- Iron, cast, changes of, in salt water, ii. (1842) 153.—Ditto, and in mines, vii. 157.
- Metals, galvanic action of the oxide of, ii. (1842) 158.
- Steam, influence of the change of temperature upon the force and pressure of, vi. 338.
- Steam boilers, causes producing, and means of preventing, the incrustation of, v. 202.
- Timber, preservation of. Absorption of salt of iron by a tree growing on a bed of scorias, ii. (1842) 89.
- Water, as to the analysis of, v. 202.—Analysis of London water, 203.
- BRANDON, D.** [Election, x. 57; resignation, xiv. 108.]
- BRANDRETH, Lieutenant-Colonel.** [Election, i. (1838) 21; memoir, viii. 12.]
- BRASS, composition of, iii. 88.**
- BRASSEY, T.** [Election, xi. 148; Member of Council, xii. 112.]
- Railways, cost of maintenance of, xi. 295.
- BRAY, W. B.**
- Bridges. "Description of the Ouse bridge, on the Hull and Selby railway," iv. 86.
- Girders. "On the strength of iron girders," i. (1837) 29.
- BRAYLEY, E. W.** [Election, i. (1839) 37.]

BREAKWATERS.

- Brazil, public works in, (Webb, E. B.), xix. 240.
- , railway system, xix. 152.
- *Vide also PUBLIC WORKS, Brazil.*
- BREAKS, *Vide RAILWAY BREAKS.***
- BREAKWATERS.**
- Cherbourg (Rennie, Sir J.), vii. 408.—(Manby, C.), xvi. 445.
- Form and construction of. "Observations upon the sections of breakwaters as heretofore constructed, with suggestions as to modifications of their forms." By General Sir H. D. Jones, R.E., ii. (1842) 124.—At Plymouth, Kingstown, Howth, Ardglass, Dunmore, and St. Jean de Luz, 124.—Constructed with a sea-slope, have not resisted the action of the sea, 124.
- Discussion.—Bull, W., 130.—Gordon, A., 127.—Jones, General Sir H. D., 125.—Macneill, Sir J., 128.—Palmer, H. B., 129.—Pasley, Lieut.-Gen. Sir C. W., 130.—Rennie, G., 126.—Robison, Sir J., 128.—Vignoles, C., 127.—Walker, J., 128.
- Form and construction of. "On the practical forms of breakwaters, sea-walls, and other engineering works, exposed to the action of waves." By J. S. Russell, vi. 135.—Of the motions of water in the waves of the sea, 135.—Forms of waves, 136.—Table of the length, period, and velocity of transmission of waves, 137.—Of the groundswell wave, 137.—Of works incidentally exposed to the action of the waves, 138.—Ditto designed to produce a direct effect on the waves of the sea, 139.—Ditto to break the waves, 140.—Ditto to act by reflecting the waves, 140.—Of means for avoiding the objections to the vertical sea wall, 141.—Of the best form of parapet for the top of the sea wall, 142.—Observations made by Mr. Thomas Stevenson, of Edinburgh, by means of a dynamometer, on the action of the waves, 142.
- Discussion.—Edwards, G., 144.—Murray, J., 143.—Rennie, Sir J., 146.—Russell, J. S., 143, 148.—Simpson, J., 145.
- Form and construction of. Use of blocks

BREAKWATERS.

of béton for the outer slopes of, (Rennie, G.) xvi. 431.

— *Vide also* BREAKWATERS, Port of Blyth.

Harwich (Rendel, J. M.), xi. 157,
Nieuwediep (Jackson, G. B. W.), vi. 106.
Plymouth, effect of the storm of February,
1848 on, (Walker, J.), i. (1841) 115.

— "Account of the original construction and present state of the Plymouth breakwater." By W. Stuart, i. (1841) 160. — Designs of Rennie and Whidby, 161. — Progress of the work, 161. — Effects of the storms in 1817 and 1824, 161. — Increase of the slopes, 161. — Effect of the storms in 1838, 161. — Quantity of stone used, 162. — Cost up to the present time, 162.

Discussion. — Rendel, J. M., 162.

Plymouth (Rennie, Sir J.) v. 39; (Walker, J.), vii. 399; (Rennie, Sir J.), 402, 414; (Rendel, J. M.) 409.

Port of Blyth. "Description of a breakwater at the Port of Blyth; and of improvements in breakwaters applicable to harbours of refuge." By M. Scott, xviii. 72. — Theory of waves: Wave of translation, 75. — Wave of oscillation, 75. — Theory of work, including the theory of form and the theory of construction, 76. — Theory of construction: stonework, 79. — Description of improvements in the construction of breakwaters, 81. — Facility of construction, 82. — Power of the work to resist waves, 84. — Durability and cost, 85. — Method proposed for completing one form of the permanent work, 87. — Apparatus for moving masses weighing more than 25 tons, 88.

Discussion. — Abernethy, J., 115. — Beardmore, N., 102. — Belcher, Admiral Sir E., 133. — Bidder, G. P., 122, 129. — Brunlees, J., 141. — Cooke, J., 102, 128. — Cooper, J., 101, 130, 141. — Hawkshaw, J., 118. — Hays, W. B., 143. — Heinke, J. W., 149. — Jones, General Sir H. D., 119, 131. — Mallet, B., 112. — Murray, J., 97, 104, 136, 141. — Parkes, W., 119. — Redman, J. B., 131. — Rennie, G., 101, 133. — Rennie, Sir J., 116, 132. —

BREMNER.

Robertson, A. J., 109, 145. — Scott, M., 150. — Walls, G., 104. — Winder, T. R., 91.

Port of Blyth. "On breakwaters." Part II. By M. Scott, xix. 644. — Completion of the Blyth work, 644. — Assumed difficulty of erecting large frames in deep water, 644. — Method by which the panels of planking were fixed and hauled down under water, 645. — Alleged deficiency in strength, 645. — Proposed form of breakwater, 646. — Points to be kept in view in the formation of harbours, and in the construction of breakwaters, 647. — Notice of the leading peculiarities of the ordinary forms of breakwater at Plymouth, Alderney, Holyhead, Portland, and Dover, 647. — The proposed breakwater, a modification of the wave-screen, 649.

Discussion. — Abernethy, J., 663. — Bethell, J., 666. — Bidder, G. P., 667, 673. — Brooks, W. A., 656. — Brunlees, J., 664. — Burnell, G. R., 665. — Cooper, J., 667. — Curtis, J. G. C., 657, 667. — Giles, A., 662. — Hawkshaw, J., 662. — Longridge, J. A., 655. — Murray, J., 667. — Robertson, A. J., 665. — Russell, J. S., 651. — Scott, M., 657, 670.

Portland, (Cubitt, Sir W.), ix. 137; (Rendel, J. M.), xi. 157.

Pulteney-Town harbour, (Bremner, J.), iii. 117. — Action of the waves upon the sea slope, 120.

Vide also HARBOURS, HARBOURS OF REFUGE, and PIERS.

Breakwaters, floating, vii. 368. — System of, for protecting the entrance to a harbour on the north west coast of Holland, xv. 23. *Vide also* HARBOURS OF REFUGE.

Breech-loading cannon for naval purposes, xix. 432.

Breech-loading rifles, McKenzie and Wentworth's, xix. 461.

BREMNER, A. [Election, xx. 258.]

Tides on the east coast of Great Britain, xx. 358.

BREMNER, D. [Election, ii. (1842) 72; Telford premium, iii. 6; memoir, xii. 148.]

BREMNER.

Bridges. "Account of the Victoria bridge erected across the river Wear, on the line of the Durham Junction railway," ii. (1843) 97.

BREMNER, J. [Telford medal, iv. 8; memoir, xvi. 113.]

Cranes, iii. 213.

Foundations under water. "Description of the caeks used for floating large stones, to construct sea-walls in deep water," iii. 122.

Pulteney town and harbour. "Account of the town and harbour of Pulteney Town (Wick, Caithness), from their origin in 1803 to the year 1844," iii. 115.

BRENDELL, HERR.

Hydraulic engines. Water-pressure engine at Freyberg, designed by him (Baker, W. L.), ii. (1843) 143.

BRENNER, Count.

Mines, experiments on the temperature of German, (Sopwith, T.), ii. (1843) 142.

Brentwood-hill railway cutting, iii. 147.

BREKTON, B. P. [Election, xix. 214.]

BRETT, J. [Election, xiii. 64.]

BRETT, J. W.

Telegraph cables, mode of construction of the cable, comparative advantages of light and heavy cables, and laying of the Mediterranean cables, from Spezzia to Corsica, and from Corsica to Sardinia, xvii. 307.—Importance of delivering the cable, in accordance with the progress of the vessel, 309.—Different forms of light cables tested for strength, before the Atlantic cable was decided upon, 321.—Failures in the attempts to lay a heavy cable between Sardinia and Africa, in the years 1855 and 1856, 321.—Importance of ascertaining the relative speed of the ship and of the paying out of the cable, 322.—Probable durability of electric cables after submersion, 322.

Brewers' horses, work performed by, and cost of, ii. (1843) 117.

— vat, beams for supporting, cast from hot-blast iron, broken, ii. (1843) 133.

BRICKMAKING.

Brewers' wort, deposit of carbonaceous substance from, ii. (1843) 170.—Contains gluten and starch, 170.

Brewery, power required to work the various machines at Messrs. Truman and Co.'s, ii. (1843) 79.

BREWIN, O.

Colonel Page's MSS. arranged by him, ii. (1843) 9.

BREWSTER, Sir D.

Neutral axis. His observations in passing polarized light through a piece of glass subjected to transverse strain referred to, with remarks thereon by Sir J. Herschel and Dr. Robison (Bell, W.), xvi. 72.

Brick and tile arches, experiments on the strength of, i. (1841) 136.

Brick arches, ancient, found at Thebes, iii. 110.—Construction of, v. 175.

Brick beam at the Great Exhibition, (White, G. F.), xi. 478.

Bricklaying, average quantity of, done per day, in building the Royal Border bridge over the river Tweed, x. 226.

BRICKMAKING.

"An account of the brickmaking at Blechingley tunnel during the winter of 1840, and summer of 1841." By F. W. Simms, ii. (1843) 145.—Arrangement of the brick grounds, 145.—Slop-moulding described, 145.—Number of persons employed, space occupied, and bricks produced, 146.—Comparison of sandstock and slop-moulding, 146, 147.—Brick-kilns, and fuel employed in burning, 146.—Drying-houses, 146.—Cost of manufacture, 146.—Mauritius sugar-mats substituted for straw hack-caps, 147.

Discussion.—Bennett, J, 147, 148, 153.—Blashfield, J. M., 149, 152.—Braithwaite, F., 152.—Buller, Capt., 151.—Cowper, E., 149, 152.—Cubitt, Sir W., 148.—Farey, J., 147, 148.—Fowler, O., 152.—Homersham, S. C., 148.—Hunt, J., 149, 152, 153.—Lowe, G., 153.—Newton, W., 152.—Parkes, J., 151, 155.—Pellatt, A., 149, 152, 153.—Simms, F. W., 147, 148.

BRICK.

Brick raising machine, Journef's, iii. 221.
BRICKS.

Ancient, "Account of some Egyptian bricks from the Pyramids of Dashoor." By J. S. Perring. Communicated by W. Newton, ii. (1843) 169.—Usually only dried in the sun, 169.—Instances of kiln burnt, 169.—Made by the captives, 170.—Dimensions and composition of, 170.—Cavities in the sides like modern bricks, 170.—Durability of, 170.

Austin's perforated, xiii. 205.

Carbonate of lime, injury arising from the use of, in the manufacture of bricks, (Walker, J.), xvi. 444.

Experiments as to the power of, to resist a crushing force, applied by an hydraulic press, (Walker, J. B.), xix. 276.

Hollow, and clay pots, used in forming roofs and floors, xiv. 523.

Ornamental, for architectural purposes, (Green, B.), iii. 112.

Use of, for bridge work, (Rennie, Sir J.), v. 84.

Weight of, when dry and when saturated, (Lane, C. B.), xi. 71.

Bridge-aqueduct of Roquefavour (Rennie, G.), xiv. 190.

Bridge-aqueducts. *Vide* AQUEDUCTS.

BRIDGEMAN, H. O. [Election, ix. 57.]

BRIDGES.

Amsterdam and Rotterdam railway, (Conrad, Chev.), iii. 174, 180.

Ancholme, constructed for the improvement of the navigation, (Rennie, Sir J.), iv. 198.

Ancient, of large span, (Rennie, G.), iii. 108.

Athlone. "Description of the bridge erected at Athlone by the Commissioners for the improvement of the river Shannon." By General Sir H. D. Jones, viii. 296.—Locality of the new structure, 296.—Difficulties in the construction and draining of the dams, 297.—Progress of the works, 297.—Stone employed, 298.—Cost of the works, 298.—Drains in the piers, 299.—Alterations in the construction of the dams, suggested by the contractor, 299.

BRIDGES.

—Appendix, extracts from the Commissioners' minutes, as to alterations in the construction of the foundations, and as to the increase in the length of the piles of the coffer-dam of the eastern pier, 301.

Discussion.—Cubitt, Sir W., 303.—Moorson, Capt. W. S., 303.—Radford, W., 303.—Walker, J., 303.

Blackfriars, paving of, (Burt, G.), xiii. 237.

Bolton and Preston railway. "On the construction of the bridges on the Bolton and Preston railway." By A. J. Adie, ii. (1842) 176.—At Cowlin Brook, Sir F. Smith's opinion of, 176.—Over the Lancaster canal, peculiar construction of the skewed arch, 178.—At Chorley road, 179.—Compound of the common and skewed arch, 179.

Chester, centering employed in the construction of, (Trubshaw, J.), i. (1837) 85.

Corby, Newcastle and Carlisle railway, (Giles, F.), iii. 208.

Drawbridge. "Description of a draw-bridge at Bowcombe Creek, near Kingsbridge, Devon." By G. C. Dobson, ii. (1843) 68.

Expanding portable, (Lavanchy, S.), xv. 27.

Floating timber, on the Great North Holland canal, (Jackson, G. B. W.), vi. 89, 91.

Insistent pontoon. "Description of the insistent pontoon bridge, at the Dublin terminus of the Midland Great Western railway of Ireland." By R. Mallet, ix. 344.—Description of the site, 344.—Swivel bridge first proposed, 345.—General idea of this bridge, 345.—Means for rapidly extracting the water, 346.—Dimensions and construction of pontoon, 347.—Valves for admitting the water, &c., 348.—Description of the syphon, 349.—Cost of the structure, 351.—Progress of the works, 351.—Applicability to other situations, 351.

Discussion.—Cubitt, Sir W., 352.—Radford, W., 352.—Warren, J. N., 352.

BRIDGES.

- Kingston. "An account of the bridge over the Thames, at Kingston, Surrey." By J. B. Birch, ii. (1842) 184.
- London, new, dimensions of arch stones, (Rennie, G.), iii. 109.
- London, old, (Giles, F.), ii. (1843) 87.—Plan and sections of, 87.—Waterway and breadth of piers, 88.—Level of the tides at, 88.—Fall of water through, 88.
- Londonderry, (Annual Report), xix, 141.
- Newark Dyke. "A description of the Newark Dyke bridge, on the Great Northern railway." By J. Oubitt, xii. 601.—Consists of two trussed girders constructed on Warren's principle, as developed by Mr. C. H. Wild, 601.—Details of girders, 601.—Tests to which the bridge was subjected, 604.—Table I., showing the amount of deflection in each pair of triangles, when the weight was equally distributed among the thirteen compartments, and was applied to each pair successively, 605.—Table II., showing the amount of deflection when the loading was commenced at one end compartment, then the second, &c., till the whole weight was put on, and observations when the load was removed, 605.—Table III., showing the amount of deflection, under different circumstances, when the bridge was completed, 607.
- Discussion.—Bidder, G. P., 608.—Fox, Sir C., 608.—Hodgkinson, E., 611.—Moorsom, Capt. W. S., 610.—Rendel, J. M., 611.—Stephenson, R., 610.—Vignoles, C., 609.
- Ouse, with opening leaves. "Description of the Ouse-bridge, on the Hull and Selby railway." By W. B. Bray, iv., 86.
- Paris. Pont de l'Alma and other bridges, built of rubble and Vassy cement (Rennie, G.), xvi. 428.
- Pont de Brioude, dimensions of (Rennie, G.), iii. 109.
- Pont-y-tu-Prydd. "Account of the Pont-y-tu-Prydd over the Taaf, Glamorgan-shire." By T. M. Smith, i. (1838) 36.
- Portumna. "Description of a bridge

BRIDGES.

- across the river Shannon at Portumna." By T. Rhodes, iii. 99.—Cast iron arches, 99.—Stone piers and mode of construction, 100.
- Railway. "Description of a bridge for a railway crossing above a turnpike road, where the depth between the soffit of the bridge and the surface of the rails is limited to twenty-one inches." By J. Pope, i. (1841) 87.—Dimensions of principal parts, 88.
- River Don, at Sprotbro'. "Description of two bridges over the river Don and the canal, with the lodge and approaches, on the estate of Sir Joseph Copley, Bart., at Sprotbro', near Doncaster." By H. Carr, x. 302.—Details of the works, 303.—Dimensions of the bridge, 303.—Details of the masonry, 304.—Details of the canal bridge, 305.—Cost of works, 305.
- Discussion.—Carr, H., 306.—Radford, W., 306.—Stephenson, R., 306.
- Rochester, x. 353, *et seq.* (Rendel, J. M.), xi. 152.
- Towing path and road, over the Nether-ton tunnel branch of the Birmingham canal, (Walker, J. R.), xix. 268.
- Vertical lift. "Description of a vertical lift bridge erected over the Grand Surrey canal, on the line of the Thames Junction Branch of the London, Brighton, and South Coast railway." By R. J. Hood, ix. 303.—Description of the line, and peculiarity of the site of the intended bridge, 303.—Dimensions and construction of bridge, 304.—Account of the obstacles which were encountered in carrying out this work, from the opposition of the Canal Company, 306.—Advantages of this mode of construction, 308.—Actual cost of work, 309.
- Discussion.—Oubitt, Sir W., 309.—Hood, R. J., 309.—Moorsom, Capt. W. S., 309.
- Warren's principle for, (Doyne, W. T.), xi. 12; (Brunel, I. K.), 14; (Rendel, J. M.), 14.
- Westminster new, (Bidder, G. P.), xix. 227.
- Vide also* BRIDGES, FOUNDATIONS of; BRIDGES, IRON; BRIDGES, LATTICE;

BRIDGES.

BRIDGES, OBLIQUE ; BRIDGES, STONE ;
BRIDGES, SUSPENSION ; BRIDGES, SWING ;
BRIDGES, TIMBER ; BRIDGES, TUBULAR
GIRDER ; and VIADUCTS.

BRIDGES, FOUNDATIONS OF.

Pneumatic system, Potts', (Clegg, S. Jun.),
x. 319.

— "On the pneumatic method adopted in constructing the foundations of the new bridge across the Medway, at Rochester." By J. Hughes, x. 353.—Site selected identical with that of an ancient wooden bridge, 354.—Brief account of ditto, 354.—Notice of old stone bridge, 354.—Details of the dimensions of the new bridge, 355.—Arrangements first made for forcing the cylindrical piles into the ground by means of Dr. Potts' pneumatic method, 355.—Process ultimately reversed, so as to give to each pile the character of a diving bell, 356.—Conditions to be answered, 356.—Mode of fitting up cylinders, 356.—Details of the air locks, 357.—Mode of dealing with the expelled water, 358.—Inquiry as to the probable limit to the use of such an apparatus, sought in the records of diving-bell work, 360.—System pursued in opening a bed of coal, underlying a quicksand 65 feet thick, near the banks of the river Loire, in France, 361.—Method of working the apparatus at Rochester, 363.—Formula for giving the number of revolutions of the air-pumps, 363.—Effect upon the men of working in compressed air, 364.—Remains of the piers of the ancient wooden bridge, 365.

Discussion.—Cubitt, J., 367.—Fox, Sir C., 366.—Hughes, J., 366, 367, 369.—Moorsom, Capt. W. S., 367.—Rendel, J. M., 366, 367, 369.—Stephenson, R., 368.—Walker, J., 367.—Wright, J., 367.

Poldevaart, in bog. "Description of the method adopted in preparing the foundation, and in building the bridge over the Poldevaart, on the line of the Amsterdam and Rotterdam railway." By the Chevalier Conrad. Translated

BRIDGES.

and compiled by C. Manby, vi. 149.—Description of the canal of the Poldevaart, 149.—Dimensions of the intended bridge over ditto, 149.—Description of the drawings illustrating the account, 150.—Ditto of the principal kinds of subsidence which occur in the execution of works in Holland, 150.—Shooting in sand to form the dam to enclose the site, 151.—Sinking of the dam, and means of prevention, 151.—Formation of one general foundation of piles for the whole structure, 153.—Excavation for the foundations, 153.—On the sudden elevation of masses of bog-earth in Holland, 154.—Ditto ditto on the sinking of the first portion of the dam, 154.—On the measures to be adopted in forming a solid foundation in bog, or other light soils, 156.

Discussion.—Bidder, G. P., 157, 158.—Borthwick, M. A., 158.—Edwards, G., 157.—Rennie, Sir J., 158.

South Wales, railway, across the river Wye at Chepstow, experiment made by Mr. Brunel near the site, to ascertain the desirability of employing cast-iron cylinders with a helical flange or screw, (Walker, J.), vii. 137.

Wells as used in India. "On the mode practised in India for obtaining solid foundations for bridges, &c., in sandy soils, by means of wells." By Capt. Goodwyn, B.E., ii. (1842) 63 ; xvi. 455.

— "Description of the method of building bridges upon brick wells, in sandy foundations ; illustrated by the viaduct over the river Poiney, on the line of the Madras railway." By G. B. Bruce, xvi. 449.—Facts regarding the Madras railway, 449.—Mode of crossing the river Poiney, 450.—Plan of obtaining the foundations, 452.—Cost of each well, 453.—Cost of the masonry of the bridge, 453.

Discussion.—Abbott, Col. Sir F., 457.—Bruce, G. B., 456.—Hawkshaw, J., 457.—Manby, C., 455.—Stephenson, R., 455.

BRIDGES.

Vide also BRIDGES; BRIDGES, IRON; BRIDGES, LATTICE; BRIDGES, OBLIQUE; BRIDGES, STONE; BRIDGES, SUSPENSION; BRIDGES, SWING; BRIDGES, TIMBER; BRIDGES, TUBULAR GIRDER; CAISSONS; COFFERDAMS; FOUNDATIONS; FOUNDATIONS UNDER WATER; and VIADUCTS.

BRIDGES, IRON.

Birmingham and Gloucester railway. "Description of a cast-iron bridge, completed in the year 1840, for carrying the Birmingham and Gloucester railway over the Avon, near Tewkesbury." By Capt. W. S. Moorsom, iii. 60.

Discussion.—Moorsom, Capt. W. S., 62. Bishop Auckland and Weardale railway. "Description of cast and wrought iron trussed-girder bridges on the line of the Bishop Auckland and Weardale railway." By J. Storey, iii. 58.

Discussion.—Grissell, T., 60.—Moorsom, Capt. W. S., 60.

Cast-iron girder, (Stephenson, R.), vi. 220.

Cauvery, Madras railway, (Heppel, J. M.), xix. 633.

Cologne, across the Rhine, proposed, (Moorsom, W. S.), xiv. 487.

Introduction of, (Rennie, Sir J.), v. 28.

Railway over the Dee, at Chester, (Stephenson, R.), vi. 220.

Southwark, experiments to ascertain the effect of temperature on the arches of, (Rennie, G.), i. (1840) 4.

Strength of, (Fairbairn, W.), xiii. 470.

Swansea, corrugated cast iron, (Evill, W., Jun.), iii. 290.

Tottenham, over the Lee, on the line of the Northern and Eastern railway, (Bidder, G. P.), vi. 220.

Vide also BEAMS; BRIDGES; BRIDGES, LATTICE; BRIDGES, TUBULAR GIRDER; GIRDERS, IRON; and VIADUCTS.

BRIDGES, LATTICE.

Dublin and Drogheda railway. "Description of a wrought-iron lattice bridge lately erected on the line of the Dublin and Drogheda railway." By G. W. Hemans, iii. 63.

Discussion.—Manby, C., 64.—Moorsom,

BRIDGES.

Capt. W. S., 64.—Pasley, Lieut.-Gen. Sir C. W., 64.—Walker, J., 64.

River Taaf, railway bridge over the, (Doyne, W. T.), xi. 11.

Rugby and Leamington railway. "Description of a wrought-iron lattice bridge, constructed over the line of the Rugby and Leamington railway." By W. T. Doyne, ix. 353.—Calculated load which might be placed upon it, 354.—Advantages of this kind of construction, 355.—Weight of iron, and total cost of this bridge, 356.—Experiments on the strength of rivets of different sizes, and under different circumstances, 356.

Discussion.—Bidder, G. P., 358, 359.—Doyne, W. T., 357, 359.—May, C., 358.—Wild, C. H., 357.

Vide also BEAMS, LATTICE; BRIDGES; and VIADUCTS.

BRIDGES, OBLIQUE.

Regent's canal. "Description of the iron skew bridge across the Regent's canal, on the Eastern Counties railway." By E. Dobson, ii. (1842) 90.

River Gaunless. "Description of an oblique bridge over the river Gaunless, on the Hagger Leases Branch railway, Durham." By J. Storey, iv. 59.—Dimensions, 60.

Discussion.—Rennie, G., 60.

Vide also BRIDGES; and VIADUCTS.

BRIDGES, STONE.

Allanton. "Description of the bridge over the river Whitadder, at Allanton (Berwick)." By J. T. Syme, iii. 101.

Bolton and Preston railway, (Adie, A. J.), ii. (1842) 176.

Boverie, Liège, over the, failure of, (Rennie, G.), iii. 111.

Dunhamstead. "Description of a bridge built of blue lias limestone, across the Birmingham and Gloucester railway at Dunhamstead." By Capt. J. Vetch, i. (1841) 136.—Mode of construction, 137.—Removal of the natural earth 'centre.'

Edinburgh and Dalkeith railway, (Adie, A. J.), ii. (1842) 177.

Mangaratiba Serra road, Brazil, (Webb,

BRIDGES.

- E. B.), xix. 250; (Brunlees, J.), 256; (Bidder, G. P.), 256.
- Middlesborough. "Description of a stone bridge on the Middlesborough railway." By J. Harris, i. (1841) 126.
- Of large dimensions, examples of, (Rennie, Sir. J.), v. 25.
- Ponte della Maddelena. "Description of the Ponte della Maddelena, over the river Serchio, near Lucca." By R. Townshend, ii. (1842) 60.
- Royal Border. "Description of the Royal Border bridge, over the river Tweed, on the York, Newcastle, and Berwick railway." By G. B. Bruce, x. 219.—Details of dimensions, 220.—Nature of surface of ground, 220.—Construction of the coffer-dams, and general arrangement of the piling, 221.—Experiments to ascertain the effect of Nasmyth's steam pile-driver as compared with the common hand-ram, 222.—Quantity of work performed by the steam piling-engine, and average cost, 223.—Comparative cost of driving with Nasmyth's engine, and the common hand-ram, 223.—Piling, 224.—Pumping-machinery, 225.—Masonry, 225.—Force employed, and work performed, 225.—Amount of work done by one crane in one day, 226.—Average quantity of work done per day by the bricklayers in building the arches, 226.—Method of preparing mortar and grout, 226.—Lime used, 228.—Experiments as to bulk of mortar compared with that of several ingredients, 228.—Centres, 228.—Temporary timber-bridge, 229.—Details of quantities of material, and force employed, in forming the embankment joining the Royal Border bridge, 230.—Appendix, experiments and observations on the velocity and regimen of the river, 231.
- Discussion.—Bidder, G. P., 239.—Bruce, G. B., 236, 243.—Cowper, C., 241.—Cubitt, Sir W., 236.—Errington, J. E., 238.—Gordon, A., 242.—Gravatt, W., 235, 240.—Hawthaw, J., 233, 234.—Jee, A. S., 240.—May, C., 233.—Moorson, Capt. W. S., 234, 238.—Penrose,

BRIDGES.

- F. C., 236.—Phipps, G. H., 235.—Radford, W., 234, 240.—Rendel, J. M., 239, 241.—Rennie, Sir J., 235.—Stephenson, R., 237, 238, 241.—Valentine, J. S., 240.
- (Rendel, J. M.), xi. 152.
- South Eak, (Adie, A. J.), ii. (1842), 177.
- Staines, experiments as to the expansion of the arches of, (Rennie, G.), i. (1840) 5.
- Stratford, new. "An account of the new stone bridge over the river Lee, at Stratford-le-Bow." By J. B. Redman, i. (1839) 77.
- Tulrow. "An account of the alterations to Tulrow bridge." By C. Forth, ii. (1842) 165.
- Victoria, across the river Wear. "Account of the Victoria bridge erected across the river Wear, on the line of the Durham Junction railway." By D. Bremner, ii. (1843) 97.—Dimensions and materials employed, 97.—Short time in which the arch stones were laid by the cranes, 98.—Coffer-dam employed in laying the foundations, 98.—Pressure upon the foundation of the highest pier, 98.—Time occupied in building, and cost of the construction, 98.
- Discussion.—Vignoles, C., 98.—Walker, J., 98.
- Wellington, at Leeds. "Account of the building of the Wellington bridge, over the river Aire, at Leeds." By J. Timperley, iii. 104.—Construction of, and materials used, 104.
- Discussion.—Green, B., 112.—Leake, Col., 113.—Page, —, 111.—Rennie, G., 107, 110, 111.
- Westminster. "History and construction of Westminster bridge, accompanied with detailed drawings." By F. Whishaw, i. (1838) 44.
- , description of the coffer-dam round the 13 feet and 14 feet piers, (Pollock, Lieut. F.), i. (1839) 66.
- Vide also BRIDGES; and VIADUCTS.
- BRIDGES, SUSPENSION.
- Bars for. "Description of a method of rolling bars for suspension bridges and other similar purposes." By T.

BRIDGES.

Howard, viii. 273.—Objections to ordinary manufacture of these bars, by welding the heads on to a parallel rolled bar, or by hammering the bars to the required form, 273.—Process of rolling the bars at once into the requisite form, 278.—Dimensions, mode of manufacture, and testing of the chains of the suspension bridge over the Danube, at Pesth, 274.—Facts elicited in proving these bars, 274.—Confirmation of the insecurity of welds, 274.—Other chains manufactured on this system, 275.

Discussion.—Brunel, I. K., 281.—Croker, B. W., 276, 277, 279.—Farey, J., 275.—Field, J., 278.—Gregory, C. H., 277.—Hooking, S., 278.—Howard, T., 275, 279.—Slate, A., 279.—Vignoles, C., 280.

Olifton, construction of, (Brunel, I. K.), i. (1841) 78.

Conway, action of wind on, (Provis, A.), i. (1841) 77.

Disturbances of. "On the disturbances of suspension bridges, and the modes of counteracting them." By A. S. Lukin and C. E. Conder, xvi. 458.—Chief sources of danger, 458.—Various modes of meeting these difficulties, 458.—Advantage in giving stiffness, combined with elasticity, to the roadway, 459.—Niagara Falls suspension-bridge, 459.—General arrangement of chains and rods, 459.—Suspension-bridge with double chains, 460.—Ditto with inclined rods, 460.—Advantage attending the use of sloping rods, 461.—Suspension-bridge with inclined rods, extending beyond the centre of the span, 462.—Convergent suspension-bridges having a double set of rods and a double set of chains, 462.—Disturbances arising from the weight of the chains, 466.—Comparison of the cost, in material, of convergent bridges and bridges with vertical rods, 467.—Effect of employing a material stronger in proportion to its weight than iron, 467.—Disturbance existing in suspension-bridges of more than one bay, 468.—

BRIDGES.

Inverted system of chains and rods below the roadway, 468.—Table of the weight of wrought-iron in chains and rods, required for different suspension-bridges, 470.—Ditto of steel ditto, 471.—Ditto of comparative tensions at highest point of one main chain, in ditto, 472.

Discussion.—Barlow, P. W., 476, 478.—Clark, E., 477.—Conder, C. E., 474.—Lukin, A. S., 473.—Stephenson, R., 473, 478.

Hammersmith, action of wind on, (Provis, A.), i. (1841) 77.

Haslar lake. "An account of a proposed suspension bridge over the Haslar lake at Portsmouth." By A. Burn, Jun., i. (1840) 52.

Invention and introduction of, (Rennie, Sir J.), v. 31.

Kieff, in Russia, (Vignoles, C.), viii. 28.

Menai. "Observations on the effect of the wind on the suspension bridge over the Menai Strait, more especially with reference to the injuries which its roadways sustained during the storm of January, 1839." By W. A. Provis, i. (1841) 74.—Fracture of rods and bearers, 75.—Nature of the undulation, 75.—Means adopted for repairing the injuries, 75.—Partial destruction of bridge in 1839, 76.

Discussion.—Brunel, I. K., 77.—Cowper, E., 77, 79.—Donkin, B., 80.—Rendel, J. M., 79.—Seaward, S., 79, 80.

Menai. "An account of the repairs and alterations made in the structure of the Menai bridge, in consequence of the damage it received during the gale of January 7th, 1839."—By T. J. Maude, i. (1841) 58.—Alterations in the roadway bearers, 58.—Ditto in the suspension rods, 59.—Ditto in the platform, 59.—Means adopted to prevent longitudinal undulation, 59.

— series of experiments for determining the dimensions of the pin, the head, and the body of the link, for the, (Field, J.), viii. 278.

Montrose. "On the state of the suspension bridge at Montrose, after the

BRIDGES.

hurricane of the 11th of October, 1838, with remarks on the construction of that and other suspension bridges in reference to the action of violent gales." By Lieut.-Gen. Sir C. W. Pasley, R.E., i. (1839) 32.

— "Memoir of the Montrose suspension bridge." By J. M. Rendel, i. (1841) 122.—The old timber-bridge over the Eak, at Montrose, 122.—Dimensions of the principal parts of the present structure, 122.—Details of the construction, 123.—Notice of an accident to the new bridge, and of reports thereon by Mr. Telford and Mr. Rendel, 123.—Alterations recommended by the latter, 124.—Partial destruction of roadway, on the 13th October, 1838, 124.—Causes thereof, and means adopted for remedying in future, 124.—Weight of the new and of the original roadways, 126.—Cost of the alterations, 127.

Discussion.—Palmer, H. R., 128.—Rendel, J. M., 127, 128, 129.—Seaward, S., 127.—Vignoles, C., 128.—Walker, J., 128.

Niagara railway, immediately above the falls, (Baker, —.) xiv. 459; (Manby, C.), 459; xvi. 459.

Railway, as to the adoption of the suspension principle for, (Barlow, P. W.), xiv. 484; (Stephenson, R.), 486.

Yarmouth (Norfolk). "An account of the failure of the suspension bridge at Great Yarmouth." By W. Thorold, iv. 291.—On the immediate cause of failure, 292.—Dimensions of the different parts, and particulars of the construction, 292.—On some additions made after its erection, and whether they indirectly caused the accident, 293.

Discussion.—Field, J., 296.—Grissell, T., 296.—Lealie, J., 295.—Mills, G., 296.—Newton, C., 295.—Phipps, G. H., 295.—Rendel, J. M., 293, 296.—Walker, J., 296.

Vide also BRIDGES; and VIADUCTS.

BRIDGES, SWING.

Herefordshire and Gloucestershire canal.

BRIDGES.

"A description of the turnbridges on the Herefordshire and Gloucestershire canal." By S. Ballard, i. (1839) 52.

River Rother, at Rye. "Account of a swing bridge, over the river Rother, at Rye, on the line of the Ashford and Hastings branch of the South Eastern railway." By C. May, xi. 422.—Chief points of difference between this and other swing bridges, 422.—Details of centre pier and of pile-driving, 422.—Ditto of cast-iron ring and rollers, 423.—Ditto of girders, 423.—Ditto of side-standards, or A frames, 424.—Ditto of the three tie-bars of centre frame, 425.—Means of turning bridge, 425.

Discussion.—Barlow, P. W., 426.—Bidder, G. P., 425.—May, C., 426.

River Wensum, at Norwich. "Account of the cast-iron swing-bridge over the river Wensum, at Norwich." By G. P. Bidder, v. 434.—Description of the large bed-plate, &c., 434.—Ditto of the mode of fixing the bridge, 435.—Ditto of the bed of the river, and of the method of forming an artificial foundation, 435.—Works executed by Messrs. H. and M. D. Grissell, 436.—Appendix, containing the weights of each portion of the bridge, 437.

Discussion.—Bidder, G. P., 437.—Pasley, Lieut.-Gen. Sir C. W., 438.—Thorold, W., 438.

Vide also BRIDGES.

BRIDGES, TIMBER.

Hilgay. "Description of a timber bridge erected over the river Ouse, at Hilgay, on the line of the Lynn and Ely railway." By J. S. Valentine, ix. 149.

Instances of the employment of, (Rennie, Sir J.), v. 33.

Mirfield. "Drawing and description of a wooden bridge erected over the river Calder, at Mirfield, Yorkshire." By W. Bull, i. (1837) 27.

Vide also BRIDGES; and VIADUCTS.

BRIDGES, TUBULAR GIRDER.

Britannia, (Cubitt, Sir W.), ix. 186; (Rendel, J. M.), xi. 152.

Conway, (Cubitt, Sir W.), ix. 186.

Strength of, "On tubular-girder bridges."

BRIGHT.

By W. Fairbairn, ix. 233.—On the construction and other matters connected with the permanency and security of this description of bridge, 234.—Experiments made at Millwall upon the model of the Britannia tubular bridge, 234.—Formula deduced from these experiments, 235.—Dimensions of Torksey tubular bridge, 236.—Want of correspondence with the formula, 236.—Estimate of the load, 237.—Table showing the proportions of tubular-girder bridges, from 30 to 100 feet span, 238.—Ditto from 160 to 300 feet span, 239.—On the force of impact, and the effect of vibration on bridges of this description, 240.—On the mode of testing bridges, 241.

Discussion.—Bidder, G. P., 246, 725.—Colthurst, J., 272.—Farey, J., 271.—Fowler, J., 245, 272.—Hodgkinson, E., 250.—Manby, C., 242, 275.—Moorson, Capt. W. S., 244.—Pasley, Lieut.-Gen. Sir C. W., 268.—Pole, W., 257.—Rennie, G., 270.—Russell, J. S., 245, 270.—Simmons, Colonel, 267, 274.—Simpson, J., 244.—Vignoles, C., 244.—Walker, J., 274.—Wild, C. H., 253, 267.—Wallis, Prof., 269, 274.

Torksey, ix. 233, *et seq.*—Analysis of the reports of the Inspecting Officers to the Commissioners of railways, and of the correspondence between the Board of Trade and the Engineer of the railway on which the bridge is situated, (Manby, C), 276.—Records of experiments on the bridge itself, to test the result of the theoretical investigations, 282.—Table of deflection, showing the calculated and the actual deflection, and the difference between them, 284.

Victoria, across the river St. Lawrence, at Montreal, (Stephenson, R.), xiv. 38; (Annual Report), 101; (Barton, J.), 478; (Annual Report), xviii. 163; (Bidder, G. P.), 227.

Vide also BRIDGES; BRIDGES, IRON; and VIADUCTS.

BRIGHT, Sir C.

Telegraph cables. Assumed difficulty of working at a commercial rate,

BRITTEN.

through the proposed Atlantic telegraph cable, xvi. 203.—Mr. Henley's instrument for overcoming the effects of induction in the underground wires between Liverpool and Manchester, 204.—Results of the completion of an underground line from London to Manchester, 204.—Mode of working through still greater lengths, 206.—Experiments with two thousand miles of underground wires, 209.—Instrument for sending alternate galvanic currents by the motion of a finger-key, 210.—Causes of the difference in the observed velocities of electric currents, 210.—Manufacture of the Atlantic cable, 223.—Submerging telegraph cables, particularly as to the use of resistors, the possibility of catching the end of the cable, should it be near the paying-out vessel, as to compensating for the rise and fall of the ship, and the comparative advantages of light and heavy cables, xvii. 302.—Difference in the condition of overground wires, and underground and submarine wires, and the importance of a good conductor, 305.—Tests to which the Atlantic cable had been subjected, 305.—Maintenance and durability of shoal-water cables, xx. 69.—Early history of submarine telegraphy, 70.—Testing for faults in submarine cables, 71.

BRINDLEY, J.

Canals. His improvements in inland canal navigation noticed (Rennie, Sir J.), v. 23.

Water, discharge of, experiments made by him and Mr. Smeaton, on the, over a waste board, (Blackwell, T. E.), x. 332.

BRINE, J. A. [Resignation, xiii. 134.]

Brioude, Pont de, iii. 109.

British Museum, distribution of fire-plugs and pipes, iii. 328.

BRITTEN, B.

Artillery, construction of, and particularly as to endeavours to improve the efficiency of the existing stock of cast-iron guns, by converting them into rifled cannon, xix. 349.—Results of

BROCKEDON.

experiments with 32-pounder guns, as smooth bores, and when rifled, 350.—Character of the projectile to be used with rifled guns, 352.—Comparative cost of cast and wrought-iron guns, 352, 355.—Opinions of practical artillerymen on the subject of range, 352.—The performance of different guns should not be compared for range alone, 353.—Presumed advantages of small-bore guns and projectiles of great length, 353.—Table giving the results of experiments as to the range, at different elevations, of rifled cast-iron guns and of wrought-iron breech-loaders, 354.

BROCKEDON, P. N. [Election, vi. 254; memoir, x. 95.]

Legacy, comprising a collection of drawings, tracings, and MS. notes on engineering works (Annual Report), x. 70.

BROCKEDON, W.

Clocks, variation of time in, iv. 75.

Gutta-percha, xii. 458.

India-rubber, specimen of his vulcanized, iv. 58.—Manufacture, cost, and application of, 58.—Details of experiments on the resistance to impact of, 59.—Statements relative to the destruction of vulcanized, under water, and as to vulcanizing, xiii. 432.

Valves, vulcanized india-rubber, xii. 458.

BRODIE, R. [Election, x. 293.]

BRODIE, J., Jun. [Election, xi. 477; memoir, xv. 94.]

Embankments across the estuaries Kent and Leven, in Morecambe Bay, xiv. 249.

BROOKS, C. H. [Council premium, xviii. 174.]

Artillery. Investigations by him, of the conditions of stress of a cylinder built up of concentric rings, xix. 329; of the effect of rotation in correcting the deviation due to want of symmetry of the projectile, 335; of the amount of error produced by the axis of the trunnions not being horizontal, 336.

—, and LONGRIDGE, J. A.

Telegraph cables. "On submerging telegraph cables," xvii. 221.

BROWN.

BROOKS, W. A. [Telford medal, xiii. 126.]

Breakwaters at Kingstown, Portland, and Blyth, and as to the situation in which the latter had been constructed, xix. 656.

Drainage of land. Level taken for the drainage of the eastern fen districts, xix. 106.

Engines; efficiency of the Nasmyth pile-engine, xviii. 512.

Rivers and estuaries. "On the improvement of tidal navigations and drainages," xii. 1.—Remarks, 21.

—, Tidal flow of the river Tyne, particularly as to the probable influence of the Tyne docks, on Jarrow Slake, upon it, xviii. 513.—As to placing weirs across navigable rivers, and as to works on the river Severn, xix. 534.

Screw-moorings in the Tyne, and the apparatus employed for inserting them, vii. 132.

Tides. Scour of the flood tide compared with that of the ebb tide, xx. 17.—Cause of the high rise of tide at Ipswich, 23.—Tidal phenomena in the Frith of Forth, 345, 355.—Tides in the North Sea, and in the English Channel, 355.—In the Frith of Dor-noch, 355.

BROUGHAM AND VAUX, Lord. [Election, ii. (1842) 184.]

BROUGHTON, F.

Railway breaks. Application of Mr. Newall's break on the Ulster railway, xix. 524.

BROUNGER, W. G. [Election, vi. 254.]

BROWN, J. [Election, xvii. 367.]

Steam-vessels, results of experiments for ascertaining the velocity of, under different circumstances (Bidder, G. P.), v. 278, 279.

BROWN, P. D. [Election, xi. 478.]

BROWN, T., R.N. [Election, xix. 461.]

BROWN, T.

Iron and steel, Bessemer process for the manufacture of malleable, xviii. 549.

BROWN, W.

Decimal coinage, &c. Progressive steps towards a decimal system of coinage,

BROWN.

and details of the system recommended by the Committee of the House of Commons, in 1853, xiii. 299.—Preponderance of opinion in favour of the pound sterling as the unit, 301.—Unit to be adopted for a decimal system of coinage, 316.

BROWN, W. [Election, vi. 431; Telford premium, ix. 95.]

Docks. "Description of the groynes formed on the south rocks, for constructing the new docks at Sunderland," viii. 186.

BROWNE, E. F. [Election, iv. 372; memoir, x. 97.]

Browne's hydraulic level (Hemming, A. F.), i. (1840), 20.

BROWNING, C. E.

Telegraph cables. Plan for regaining the sunken end of a submarine cable in case it should break while being payed out, xvii. 332.

BROWNING, F. R. [Election, xix. 263.]

BROWSE, H.

Roads, macadamized, for streets of large traffic, xiii. 234.

BRUCE, G. B. [Election, ix. 303; Telford medal, xi. 68, 87, 118; Council premium, xvii. 80.]

Bridges. "Description of the Royal Border bridge, over the river Tweed, on the York, Newcastle, and Berwick railway," x. 219.—Remarks, 236.—Combination of ashlar and rubble in the piers of the bridge, 236.—Quantities of work in ditto, 237.

Building-stones, resistance of various, to vertical pressure, x. 243.

Execution of works. Inexpediency of interfering with the ordinary native methods of doing work in foreign countries, xix. 258.

Foundations. "Description of the method of building bridges upon brick wells, in sandy foundations; illustrated by the viaduct over the river Poiney, on the line of the Madras railway," xvi. 449.—Difference in the methods practised in Bengal and in Madras for obtaining foundations, 456.

Permanent way of the Madras railway,

BRUFF.

particularly as to the use of wooden sleepers in India, xviii. 423.

Pier at Southport, Lancashire, xx. 298.

Public works in India. As to the slow progress of the Indian authorities in the matter of public roads, xvii. 529.

—Over-statement of the percentage derived from public works in India, 529.

Railways. Difference in the nature of the guarantees, causing the guaranteed shares of some Brazilian railways to be at a discount, xix. 268.

—, **Indian.** Relative cost of the Madras and the Bengal railways, xvii. 529.—Reasons which induced him to depart from the usual contract system, in the construction of the Madras railway, and manner in which the works were executed, xix. 617.—Adoption, on Indian railways, of the substantial system of construction, in contradistinction to what was called the American system, 618.—Prices of labour in the Madras Presidency, and on the Great Southern of India railway, 619.—Improvement of the people due to the railway works, 619.—Guarantee system, 619.

BRUFF, P. [Election, i. (1840) 61.]

Harbours of refuge. Necessity for a harbour of refuge at Aldborough, on the Suffolk coast, xx. 359.

Levelling staff, improved, i. (1838) 47.

North Sea, as to the tides in, and the bed of the, xx. 358.

Permanent way of Eastern Union railway, xi. 476.—Permanent way of railways, particularly of the Eastern Counties' lines, xvi. 281.—Invention of the fish-joint, 282.—Proper weight and strength to be given to rails, 282.—Permanent way of the Eastern Counties Colchester line, and of the Had-discote and Halesworth line, 382.—Permanent way without chairs, xx. 283.

Railway cuttings, iii. 147, 158.

River Orwell and the Port of Ipswich, xx. 14, 23.

Viaducts. "Description of the Chapple

BRUNEL.

viaduct, upon the Colchester and Stour Valley extension of the Eastern Counties railway," ix. 287.—Remarks, 292.—Cost compared with that of certain laminated timber viaducts, 292, 293, 294.—Centering, &c., 292.

Wells. Supply of water to the town of Colchester from a well sunk into the chalk, with a list of the strata passed through, xix. 38.—Artesian boring at Harwich, and the strata passed through, 39.

BRUNEL, I. K. [Member of Council, i. (1837) 15; (1838) 20; (1839) 27; (1840) 36; (1841) 52; iv. 62; v. 142; vi. 46; vii. 56; viii. 44; Vice President, ix. 91; x. 60; xi. 84; xii. 112; xiii. 123; xiv. 97; xv. 76; xvi. 88; xvii. 70; xviii. 164; memoir, xix. 169.]

Arches. Compressibility and elasticity of materials of construction, v. 173.—Extent of analogy between the arch and a trussed girder, 175.—Line of pressure in arches, 177, 180.

Boilers, action of priming in different, viii. 183.

Bridges. Causes of injury to suspension bridges, i. (1841) 77.—Construction of the Clifton suspension bridge, 78.—Suspension, particularly as to the proportions between the pin, the head, and the body of the link, and as to rolling the bars at once into the requisite form, instead of welding on the heads, viii. 281.—Lattice, compared with Warren's girder, xi. 14.

Datum line, as to the establishment of a general, throughout England, v. 312.

Decase, notice of his, by Mr. J. Locke, M.P., President, xix. 1.—In Annual Report, 164.—In the address of Mr. G. P. Bidder, President, on taking the chair, for the first time after his election, 214.

Docks. Dock entrances, vii. 182.—Different effects produced by sluicing and scouring, and action of scouring conduits at the Sunderland docks, xv. 449.

Electric telegraph, relative advantages

BRUNEL.

and disadvantages of the underground and overground systems of stretching the wires for the, xi. 376.

Engines. Action of the 'regenerator' in Ericsson's caloric engine, xii. 349, 350.

Fluids, elastic, discharge of, under pressure, vi. 386, 390.—Experiments made for M. Montgolfier, on the application of the mechanical power of carbonic acid and other gases, condensed under pressure, ix. 199.—Experiments on condensed carbonic acid gas, 200.

Furnaces, admission of air to, and smoke-prevention apparatus, xiv. 26.

Girders. Form of wrought-iron girders, and testing girders for iron viaduct at Manchester, xi. 237.

Governmental functions. Objections to Government interference in all public undertakings, viii. 134.

Hydraulic traversing-frame on the Great Western railway, iii. 129.

India-rubber, effects of compression and extension upon vulcanized, xii. 457.

Iron, importance of good quality of, xii. 379.

Lock-gates, iron, for the docks at Sevastopol, vi. 55.

Locomotive boilers, use of American white cedar wood for covering, i. (1840) 45.

Locomotive engines, construction of, particularly as to engines with the driving-wheels placed behind the fire-box, as to causes tending to produce steadiness, and as to the distribution of the weights upon the wheels, viii. 242, 252.—Combustion of fuel in fire-box of, xi. 402.

Manometer, metallic, and other instruments for measuring pressures and temperatures, xi. 22.

Permanent way, method of constructing the, in the United States, vi. 79.—Advantages of the longitudinal sleeper system, and of the wrought-iron joint-plate, and as to the manufacture and form of rails, viii. 266, 268.—Longitudinal system of laying permanent way, ix. 403, 404.—Saddle-back rail, xi. 274.—Effect of traffic on

BRUNEL.

- bridge rails and longitudinal bearings, 274.—Unnecessary in this climate, in laying rails, to provide for contraction and expansion, 275, 286.—Split-rail, 276.—'Fishing-plates,' with suspended joints, 278.—Modification of forms of rails, 287.—False top to rails, 287.
- Railway, atmospheric, iv. 147, 150.
- Railway companies. How far they can, with advantage, become manufacturers, xi. 471.
- Railway traction. Diagrams produced by the dynamometer when applied to determine the traction on railways, v. 285.
- Railway trains, resistances to, and mode of conducting experiments for ascertaining the, vii. 299, 308, 318.—Sources of error in experiments on inclined planes, 306, 313.
- River Thames, nature of the strata in the bed of the, at the site of the Tunnel, ix. 18.—Effect upon the atmosphere of the rise and fall of the tide in the river Thames, xv. 229.
- Roof over the Bristol station of the Great Western railway, viii. 285.
- Safety-valves of locomotive boilers, xv. 39.
- Sea-walls, best form for, vi. 124.—Injury sustained by a sea-wall on the South Devon railway, vii. 193.—Comparison between vertical and sloping walls for sea-defences, 193.
- Steam navigation, &c. Allusion to his exertions in accelerating the progress of ocean steam navigation (Bidder, G. P.), xix. 214.
- Street-paving. Mode of gauging paving-stones, ix. 223.
- Timber, preservation of, xii. 233.
- Viaducts, general cost of, and on the circumstances which determine the span of the arches, ix. 292.
- Water meters, use of, for indicating the quantity of water supplied to boilers, xiii. 430.—Kennedy's meter, on the piston and cylinder system, 430.
- Weirs, relative advantages of oblique and square, v. 351.

BRUNLEES.

- BRUNEL, Sir M. I.** [Telford medal, i. (1839) 5; memoir, x. 78.]
- Arches. Model showing a method of erecting an arch without centering, i. (1838) 11.
- Beams. Strength of brick beams, i. (1838) 20.
- Machinery. Improvements introduced by, in machinery for the conversion of timber (Molesworth, G. L.), xvii. 17.
- Ruthven's propeller. System of propulsion somewhat similar to Ruthven's, xiii. 374.
- Scaffolding, model of the, used in building the monument on Fish-street-hill, iii. 216.
- Thames tunnel, i. (1837) 33; (1838) 5, 23, 41; (1839) 44.—Poling boards used at, i. (1838) 5, 23.—Shield at the i. (1838) 46.
- "An account of the actual state of the works at the Thames tunnel (June 23, 1840)," i. (1840) 85.
- , his exertions in completing, (Walker, J.), ii. (1843) 29.—Further account of the poling boards of the shield, &c., 80.
- Timber. "On a mode of dowelling timber, or of combining it and other materials for general purposes," i. (1840) 6.
- BRUNLEES, J.** [Election, xii. 109; Council premium, xv. 81, 104; xviii. 175.]
- Breakwaters, relative cost of timber and stone, xviii. 141.—Protection afforded by a wave-screen, 141.—Relative merits of the upright wall, or the sloping face, 142.—Iron pier at the river Plate, 142.—Staging employed at the Portland and Holyhead breakwaters, 143.—Proposed cast and wrought iron breakwater and pier, xix. 664.
- Bridges. Cost of a cut-stone bridge on the Mangaratiba Serra road, Brazil, xix. 256.
- Permanent way. Preparation of the timber sleepers used on the Bolton and Preston railway, with a saturated solution of arsenic, xviii. 435.
- Pier at Southport, Lancashire, commercial success of the, xx. 298.
- Railway embankments. "On the con-

BRUNTON.

struction of the sea-embankments across the estuaries Kent and Leven, in Morecambe Bay, for the Ulverstone and Lancaster railway," xiv. 239.—Remarks, 246, 249.—Drawbridge to be used on the line crossing the Leven, 246.—Embankment for the Londonderry and Coleraine railway, across Rosse's Bay, 249.

Railways. Difference in cost of Irish and of English railways, xviii. 46.

Timber, deterioration of, in sea-works in warm climates, xix. 664.

Viaducts. "Description of the iron viaducts erected across the tidal estuaries of the rivers Leven and Kent, in Morecambe Bay, for the Ulverstone and Lancaster railway," xvii. 442.—Remarks, 448.—Mode of sinking the piles, 448.

BRUNTON, J. [Election, xvi. 226.]

BRUNTON, R. [Election, ii. (1842) 72; memoir, xii. 149.]

BRUNTON, T. [Election, iii. 248.]

BRUNTON, W. [Election, xiii. 364; memoir, xi. 95.]

Iron, as to making, with anthracite, ii. (1843) 130.

Mine-ventilator at the Gelly Gaer colliery (Manby C.), x. 55.

Brunton's circular fire-grate for preventing smoke, xiii. 390.

BRUSSAUT, P. A. de.

Axle-boxes. "On a new system of axle-boxes, not requiring lubrication, and without liability to heating," xviii. 406.

BRYDGES, C. J. [Election, xii. 109.]

BYDONE, W. M. [Election, xviii. 231.]

BUCCLEUCH AND QUEENSBURY, DUKE OF. [Election, ii. (1842) 184.]

Annales des Mines de France, present of a complete set of the, ii. (1843) 200; iii. 9, 25.

BUCHANAN, G. [Election, xvi. 423.]

Coal-field, account of Midlothian, v. 338.

Buck and Lacy's permanent way, xvi. 244.

BUCK, G. W. [Memoir, xiv. 128.]

Locomotive boilers, tubing of, i. (1838) 51.

— "On tubing the boilers of locomotive engines," i. (1839) 32.

Railway cuttings, iii. 153.

BUCKLAND.

Buckets of water-wheels (Mallet, R.), ii. (1843) 60.

Buckingham Palace, roofs covered with Lord Stanhope's composition (Hogg, P.), ii. (1843) 94.

BUCKLAND, Dr. (Dean of Westminster). [Election, ii. (1842) 122; memoir, xvi. 102.]

Clay. Nature and extent of the London clay, ix. 15, 21.—Difference between ditto and blue clay, 16.—Hard clay at Leith, ix. 21.

Coal-field, geological features of the South-Western, ii. (1842) 139.

Drainage of towns. Nuisances arising from the defective drainage of Bristol, vii. 84.—Flushing the metropolitan main sewers, 85.—Use of various deodorizing fluids, when emptying cess-pools, 92.—Evils arising from open sewers, 93.

Gas. Lighting of metropolitan thoroughfares, and best form of gas-burner, vii. 85.

Geological strata, importance of knowing precisely the nature of the, to be met with in engineering works, illustrated by the example of the Thames tunnel, ix. 14.

Geology. Importance of a knowledge of geology to civil engineers, vii. 243.

London basin. Supply of water from the chalk basin of London, ii. (1842) 158, 162.—The Rev. J. C. Clutterbuck's paper on the water in the chalk, ii. (1843) 165.

Marine worms. Action of 'Pholades,' and other boring marine worms, ix. 41. Mode of propagation and dispersion of the 'Teredo navalis,' 43.—Modes of action of the 'pholas' and 'teredo,' and on the use of creosote for protecting wood from the ravages of marine worms, 48.

Mines. Models of mining operations, i. (1841) 167.—Advantages that would result from government inspection of mines, vi. 194.—Means of improving the ventilation of mines, 195, 203.—Dangers to be apprehended from the 'goaf,' 205.

BUCKLE.

Moulds. Mode used by Sir John Robison for obtaining moulds for plaster casts, i. (1841) 166.

Rivers and estuaries. Silt of the Humber, ix. 14.—Difference between silt of the Humber and that at Southampton, 20.

Roofs. Timber roof of Westminster Abbey, viii. 286.

Sea-walls. Cob wall, at Lyme Regis, vii. 202.

Sewage. Application of liquid manure for agricultural purposes, especially on the Duke of Portland's estate, near Mansfield, and on some meadow land near Edinburgh, vii. 93.—Proposal for establishing a manufactory of 'poudrette,' 94.

Steam boilers. As to preventing alkaline incrustations in boilers, viii. 177.

Stone, artificial, manufacture of, with a silica base, and experiments of Humphry, Watt, and Sir John Hall in that direction, vii. 66.

Thames tunnel borings, i. (1841) 167.—Strata in the bed of the Thames at the site of the tunnel, ix. 14, 19.

Tunnels of the Great Western railway, ii. (1842) 139.

Water supply. Origin of the flow of water from artesian and other wells, and on supplying the metropolis with water, v. 479.—Quality of the water from the well at the Camden station, viii. 173.

Wells. Artesian well at Grenelle, i. (1841) 167.—As to artesian wells, ii. (1842) 158.—New system of boring tried with success at Perpignan, vi. 195.

BUCKLE, C. R. [Election, i. (1838) 29.]

BUDD, J. P. [Election, x. 57; resignation, xv. 85.]

BUDD, T. [Election, i. (1840) 83.]

Sluices. "Description of Ohelson Meadow sluice," ii. (1842) 62.

BUDICOM, W. B. [Election, iv. 323.]

BUDDLE, J. [Memoir, iii. 12.]

Mines, temperature of English, ii. (1843)

142.—German machine for raising

kibbles from mines, 194.—Speed of

drawing from the pits at Newcastle, 195.

Steam-boilers, explosion of, i. (1838) 43.

BUOYS.

Bude light, ii. (1843) 189 *et seq.*

Building materials on Birmingham and Gloucester railway, ii. (1842) 54.

— stones, resistance of, to vertical pressure, x. 243.

Buildings, fire-proof, construction of, (Fairbairn, W.), vi. 213; (Barrett, J.), xii. 244.

Bulkheads, iron, watertight, introduced by C. W. Williams, ii. (1843) 179.—Wood not so good as iron for bulk-heads, 179.—Number necessary to save a vessel, 179.

BULL, W.

Breakwaters, objections to General Sir H. D. Jones' proposed forms of, ii. (1842) 131.—Best form for, 131.

Bridges. "Drawing and description of a wooden bridge erected over the river Calder, at Mirfield, Yorkshire," i. (1837) 27.

River Calder, mode of protecting the banks of the, ii. (1842) 130.

Timber, experiments on Kyanised, ii. (1842) 86.

BULLER, Captain.

Brickmaking, ii. (1843) 151.

BUOYS, BEACONS, SEA-LIGHTS, ETC.

Construction of. "On the construction of stationary floating bodies." By G. Herbert, xv. 1.—Form and construction of buoys ordinarily in use, and manner of mooring, 1.—Herbert's wrought-iron buoys, 2.—Buoy, or sea-beacon, on principle of ditto, of 30 tons displacement, 3.—Trial of ditto on South Sand Head of the Goodwin Sands, 3.—Cause of apparent failure of ditto, 5.—Proposed circular, wrought-iron, sea-light tower on same principle, 6.—Power of wind and tide on ditto, 7.—Observations on the movement of the waves off the Scilly Islands, 8.—Cost of Skerryvore, Bell Rock, and Edystone light-houses, and estimated cost of three sea-light towers to mark those positions, 9.—Proposal to exhibit a fairway, or guiding light, in the entrances to the principal channels, 9.

Discussion. — Baylis, I. 17.—Beechey, Admiral, 16.—Belcher, Admiral Sir

BURGES.

- E., 11, 15.—Cowper, E. A., 11.—Croker, B. W., 23.—Fitzroy, Admiral, 11.—Gordon, A., 10.—Gordon, Capt., 16, 21.—Halsted, Capt., 18, 23.—Herbert, G., 11, 13, 16, 23.—Moorsom, Capt. W. S., 14.—Poulter, Capt., 14.—Rogers, —, 16.—Russell, J. S., 15.—Shepherd, Capt., 21, 23.—Simpson, J., 23.—Washington, Capt., 10.
- Fixed and floating lights, comparative merits and expense of, (Washington, Capt.), vii. 139.
- Goodwin Sands, beacons, &c., proposed for, (Walker, J.), vii. 136; (Welbank, Capt.), 138; (Washington, Capt.), 139.
- Screw-pile and moorings for, (Mitchell, A.), vii. 108. *Vide also* FOUNDATIONS UNDER WATER.
- Vide also* BEACONS, FLOATING.
- BURGES, A. [Election, i. (1839) 33; Member of Council, i. (1841) 52.]
- Smeaton, J., present of portrait of, i. (1841) 13.
- BURGOYNE, General Sir J. F., R.E. [Election, i. (1839) 37.]
- Artillery, construction of, and effect which long-range rifled ordnance would have upon fortifications, xix. 356.
- BURKE, J. St. G. [Election, i. (1840) 54; resignation, viii. 9.]
- BURLING, B. [Election, xii. 272.]
- Permanent way. "On the construction of railway switches and crossings," xiv. 419.—Remarks, 431, 435.—Duration of railway switches and crossings, 433, 435, 436.
- , his cast iron wedge chair, and iron key (Adams, W. B.), xvi. 240.—His cast iron wedge sleeper, 257.
- , Trials of different systems of permanent way on the Great Northern railway, particularly of Mr. Parsons' chairs with end-grain wood packing, of Mr. De Bergue's cast-iron sleeper-way, and of Mr. Adams' suspended girder-rail, xvi. 275.—Iron permanent way, xx. 283.
- BURN, A. [Election, i. (1839) 46; Premium, i. (1841) 10.]

BURY.

- Bridge, suspension. "An account of a proposed suspension bridge over the Haslar Lake, at Portsmouth," i. (1840) 52.—Remarks, 53.—Dimensions of the principal parts, 53.
- BURNELL, G. R.
- Cements, difference between natural and artificial, xvi. 445.
- Concrete, blocks of, used at Dover, Alderney, Cherbourg, &c., xvi. 438.—Application of, for building-purposes, 444.
- Mines. M. Gonot upon the introduction into Belgium of the system of lighting mines by means of coal-gas, xvii. 9.
- Bubble masonry, xvi. 437.—Failure of the Barentin Viaduct on the Havre railway, built of limestone, set in chalk lime, 437.
- Timber from the north-west coast of America, xviii. 294.—Creosoted timber, and capability of green-heart timber to resist the attacks of the teredo, xix. 665.
- BURNETT, Sir W.
- Deodorizing preparation, his chloride, or muriate of zinc, as a, (Chadwick, E.) vii. 98.
- BURNEY, J. B.
- Smoke, prevention of, experiments with an apparatus on board the 'Citizen' steamboat E, xiv. 19.
- BURNS, J. [Election, xx. 586.]
- BURSTAL, Captain, R.N.
- North Sea, the, its supposed gradual filling up, and as to the Dogger bank, xx. 346.—Currents over the Dogger bank, 362.
- BURT, G.
- Bridges. Paving of Blackfriars-bridge in 1840, xiii. 237.
- BURT, H. P. [Election, v. 433; Auditor, xiii. 122; xiv. 96; Telford medal, xiii. 127.]
- Timber. "On the nature and properties of timber, with descriptive particulars of several methods now in use for its preservation from decay," xii. 206.—Remarks, 223.—Process of creosoting, and its effects, 223.
- BURY, E. [Resignation, xvi. 98.]
- Locomotive engines. "An account of

NOTICE.

COMPLETE sets of the Minutes of Proceedings, Vols. I. to XX., may be obtained, by members (of all classes) only, at the house of the Institution ; or copies of single volumes, or parts, to perfect sets.

The cost of the entire series is :—

	£	s.	d.
If in paper covers . . .	9	18	0
If bound in green cloth . .	11	8	0

The cost of Vols. I. to XVI., inclusive, is 9s. each, and of Vols. XVII. to XX., inclusive, 13s. 6d. each, in both cases in paper covers. The cost of the binding of each volume is 1s. 6d.

BURY.

the performances of the locomotive engines on the London and Birmingham railway during the year 1839," i. (1840) 83.—Remarks, 48, 49.
—American locomotive engines, 48, 49.

BURY, T. T. [Election, vii. 326.]

BUST, in marble, by Hollins, of the first president, Telford, recovered for the Institution (*vide* REPORT), xiii. 129.—Of Mr. R. Stephenson, M.P., by E. H. Baily, R.A., presented to the Institution. *Vide* ANDREWS, J.

BUTLER, J. O. [Election, iii. 101.]

BYRNE.

BUTLER, R. [Election, xiii. 364.]

Butterley iron-works, description of the blast-furnaces at, (Kreeft, S. C.), ii. (1843), 119.

BUTTERTON, W.

Bridge, cast-iron, over the Avon, near Tewkesbury, drawings of the, iii. 62.

Buttresses of gravel in the slopes of railway cuttings, iii. 144, 149.—Of stone or brick to retaining-walls, 356.

BYNOE, N. L. [Election, xvii. 540.]

BYRNE, E. [Election, xvi. 226.]

BYRNE, H. [Election, xx. 191.]

BYRNE, J. W. [Election, xvi. 423.]

C.

CABLE.

Cable, chain, and timber testing machines (Dunn, T.), xvi. 301.

Cables, submarine telegraph, tabular description of the construction of the principal, arranged chronologically, with remarks thereon, xvi. 194.

Vide TELEGRAPH CABLES.

CAISSON, SLIDING.

"Description of the sliding caisson at Keyham dockyard." By W. Fairbairn, xiii. 444.—Caissons for closing the entrances to wet or dry docks first suggested by General Sir S. Bentham, 444.—Ordinary floating caisson not calculated for the wide entrance to the Keyham docks, 444.—Description of these docks, 445.—Leading features of the construction of the caisson, 446.—Table showing the calculated strengths of the different compartments of the caisson, with the ratios of the pressure to the ultimate resistance, 448.—Facilities for opening and shutting the entrances of tidal basins, 448.—Culverts through air-chamber for scouring the entrance to the basin, 448.—Tidal ballast-slucies, 449.—Mode of opening and closing the lock, 449.—Method of removing the caisson for repairs, painting, &c., 451.—In what this caisson differs from those of ordinary construction, 451.—General dimensions and details, 452.—Means of floating, 453.—Experiments for the purpose of ascertaining the powers of resistance to pressure, and the amount of deflection caused by different depths of water pressing upon the outside, 454.

Discussion.—Armstrong, Sir W. G., 458.—Bentham, Lady, 459.—Fairbairn, W. 457, 459.—Murray, J., 458.—Radstock, Lord, 458.—Rankine, W. J. M., 458.—Scamp, W., 456.—Simpson, J., 463.—Walker, J., 458.

Caissons, cast-iron, used for constructing

CALVERT.

the piers of the bridge over the Avon, near Tewkesbury, iii., 60.

—, or water-tight chests, for water building, when and where first introduced, v. 26.

Calculating machines. Automaton calculator, invented by Dr. Roth, iii. 68.—Historical account of various machines for facilitating calculation, 69.—Sir S. Morland's treatise on "Arithmetick Instruments," 1673, iii. 70.—Scheutz's difference engine, and Babbage's mechanical notation, xv. 497.—Scheutz's calculating machine, xvi. 225.—Specimens of tables, calculated, stereomoulded, and printed by machinery, 422.

Vide also ARITHMETICAL INSTRUMENTS.

Calculation, mental, (Bidder, G. P.), xv. 251.

Calculator, the land-surveyor's, (Heald, G.), i. (1838) 25.

Calder, river, mode of constructing the banks of, ii. (1842) 130.—Pitching the banks, 130.—Floods in, 130.

—, viaduct (Macneill, Sir J.), ii. (1842) 189.

Caloric engine (Manby C.), xii. 558; (Leslie J.), 563. *Vide* also AIR ENGINES.

CALVERT, F. O.

Fuel. Removal of sulphur from coal during the process of coking, xii. 380.

Iron, cast. "On the increased strength of cast iron, produced by the use of improved coke," With a series of experiments by W. Fairbairn, xii. 352.—Remarks, 379.—Present state of the manufacture of iron, 379.—Necessity for the employment of some medium for neutralizing the effect of sulphurous slags, 380.

CALVERT, J.

Gold. Auriferous strata in different parts of the world, xv. 60.—Three specimens of gold quartz, 61, 62.—Process

CAMELS.

of extracting gold, described by old German alchymists, in the fifteenth century, 61.—Specimen of Welsh gold, 61.

Camele, water, for lifting vessels over sand-banks and shoals, vi. 82.

CAMERON, J. [Election, xvi. 46.]

CAMMELL, C. [Election, viii. 273.]

CAMPBELL, D.

Sea-water, chemical composition of, xiv. 519.

Wells. Presence of soda-salts in the deep wells under London, xiv. 518.—Quality of water derived from chalk under London, 522.

CAMPBELL, P. L. [Election, v. 433; memoir, viii. 14.]

Canal-boats, fast, introduction of, v. 77.—Sir J. Macneill's experiments on towing by a locomotive engine, xiii. 212. *Vide* also BOATS.

CANAL INCLINE PLANES.

"Description of an inclined plane for conveying boats over a summit to and from different levels of a canal." By J. Leslie, xiii. 205.—Blackhill incline, on the Monkland canal, near Glasgow, over which the boats are taken up afloat, in a water-tight caisson, 205.—Difficulty in adapting a carriage fit to carry a heavy boat to surmount a summit, and to descend again, 206.—This difficulty overcome on the Morris canal (U.S.), 206.—Modification proposed, to have two uniform inclined planes, descending each way, from a suitable elevation above the surface of the water in the upper reach, 207.—Advantage of caisson plan, 208.—Plan of taking vessels into a small dock, by the side of the Vistula, at Warsaw, 209.

Discussion.—Armstrong, Sir W. G. 212.—Bidder, G. P. 210, 212.—Cubitt, Sir W., 210.—Gibbs, J., 209, 210.—Gravatt, W., 209.—Hawkshaw, J., 210, 211.—Hobbs, A. C., 212.—Homersham, S. C., 210.—Leslie, J., 212.—Maudslay, H., 211.—Rawlinson, R., 211, 212.—Rendel, J. M., 210, 212.—Vignoles, C., 209, 211.

CANALS.

CANAL LIFTS.

"The canal lifts on the Grand Western canal." By J. Green, i. (1838), 26.

Discussion.—Green, J., 28.—Parkes, J., 28.—Walker, J., 28.

CANALS.

Atlantic and Pacific oceans, proposed ship, between the, (Glynn, J.), vi. 399.—Facilities for a ship canal by Isthmus of Panamá, (Lloyd, Col. J. A.), ix. 58. *Vide* also JUNCTION of the ATLANTIC and PACIFIC OCEANS.

Banks of, subsidence of, (Walker, J.), iii. 170; (Green, J.), 170, 171.

Birmingham, Netherton tunnel branch. "Description of the works on the Netherton tunnel branch of the Birmingham canal." By J. R. Walker, xix. 263.—Brief account of the navigation belonging to the Birmingham Canal Company, 263.—Range of hills through Rowley Regis, Dudley, and Sedgley, pierced by the Old Dudley tunnel, 264.—The original canal from Birmingham to Autherley, 264.—The Tame Valley canal, 264.—The Dudley tunnel afforded a means of communication between the Birmingham and the Dudley canals, and process of propelling boats through the tunnel by 'legging,' 265.—Act obtained for the construction of a new canal and tunnel, on the Birmingham Level, from Netherton to Dudley Port, 265.—General description, extent, and time occupied in the construction of the works, 266.—The towing-path walls, 267.—The basins, or docks, 268.—Towing-path bridges over the entrances of three of these basins, 268.—Road bridges over the canal, and details of the Birmingham and Sedgley turnpike-road bridge, 268.—Towing-path bridges across the canal, 269.—Brick aqueduct for the Wolverhampton Level canal, at Tividale, 269.—Brick aqueduct over an occupation road near Dudley Port, 269.—The stop-locks, 269.—Sinking of the shafts for the construction of the tunnel, their total depth, and the rate of progress, 270.—

CANALS.

Dimensions of the tunnel, and thickness of the brickwork, 271.—Forcing up of the invert, 272.—The trough of the canal in the tunnel, 272.—Process of excavation and construction of the tunnel, 272.—Nature of the strata passed through, 273.—Casualties during the execution of the works, 274.—Character of the mortar and brickwork, and strength of the bricks employed, 274.—Appendix: Experiments as to the power of bricks to resist a crushing force, applied by a hydraulic press, 276.

Discussion.—Bateman, J. F., 279.—Beardmore, N., 278.—Bidder, G. P., 281.—Cooper, J., 278.—Fowler, J., 280.—Hemans, G. W., 278.—Locke, J., 277.—Vignoles, C., 278.—Walker, J. B., 277, 280.

Brindley's improvements in inland canal navigation, (Rennie, Sir J.), v. 23.

Caledonian, steam dredging engine used upon, (Elliott, W.), ii. (1842), 149.—Coffer-dams used by Telford for founding the sea-locks at Fort-William and at Inverness, (Rennie, Sir J.), v. 42.—Method employed in the construction of the sea-lock at Corpach, at the western end of the, (Rennie, Sir J.), xiv. 39.

Dynamometer for measuring the friction on, (Carr, H.), i. (1840) 52. *Vide also* DYNAMOMETER.

Egypt and Isthmus of Suez, (Glynn, J.), x. 369. *Vide also* ISTHMUS OF SUEZ.

England, position of canals generally, in reference to the development of their resources, (Beardmore, N.), vii. 393. *Vide also* RIVERS, Lee.

Exeter.—“Mémorial of the canal of Exeter, from 1563 to 1724.” By P. C. De la Garde; with a continuation, by J. Green, iv. 90.—Estimate for the completion of, in the year 1699, 98.

—“Continuation of the memoir of the canal of Exeter, from 1819 to 1830.” By J. Green, iv., 102.—Summary of reports from 1820 to 1826, 106.

Discussion.—Oubitt, Sir W., 111, 113.—Green, J., 111.—Randel, J. M., 113.—

CANALS.

Rennie, Sir J., 111, 113.—Stephenson, R., 112.

Exeter, ship, subsidence of the banks of, (Green J.), iii. 170.

France, for irrigation in the Departments of Vaucluse, Gard, Var, and Dauphiné, (Rennie, G.), xiv. 191. *Vide also* AQUEDUCTS, Roquefavour.

Ganges, (Tremenheere, Maj.-Gen.), xix. 492. *Vide also* PUBLIC WORKS, India.

Grand Junction, experiments on the force of traction of the boats (Rennie, G.), ii. (1843) 115.

Great North Holland. “Description of the Great North Holland canal, with an account of the mode of gaining land from the sea by polders, and of the art of building with fascine work, and an account of the works at Nieuwediep.” By G. B. W. Jackson, vi. 81.—Difficulties of the navigation between the mouth of the Texel and the city of Amsterdam, which led to its construction, 82.—Description of water-camels for lifting vessels over sand-banks and shoals, 82.—Ditto of a floating dry-dock at Amsterdam, 83.—Course of the canal, 84.—Levels of ditto, 85.—General dimensions of ditto, 85.—Difficulties attending construction of ditto, 86.—Experiments for testing the character of the ground by pile-driving, 87.—Ditto by boring, 87.—Results of the foregoing experiments, 89.—The excavations, and mode of carrying them on, 89.—Mode of constructing, and dimensions of, the fascine embankment dividing off the Alkmaar Lake, 90.—Ditto ditto of the Koegrass sea-dyke, 91.—Description of the timber floating-bridges, 91.—Ditto of the double Willem lock opposite Amsterdam, 92.—Ditto of several other locks beyond Amsterdam, 94.

Discussion.—Bidder, G. P., 181.—Brunel, I. K., 124.—Clarke, H., 112, 118, 181.—Cubitt, Sir W., 111, 112, 118, 132.—Curtis, J. G. C., 125.—Edwards, G., 117.—Jackson, G. B. W., 110, 117, 123.—Redman, J. B., 123, 181.—Ren-

CANALS.

- nie, G., 113.—Rennie, Sir J., 120, 126, 130.—Russell, J. S., 129, 132, 133.—Stephenson, R., 115, 123, 124.—Walker, J., 110.—Wright, J., 132.
- Ice-breaking, method employed on the Herefordshire and Gloucestershire canal, (Ballard, S.), i. (1837) 18.—Ice-boat, used in, i. (1838) 47.
- India, evaporation of water from, (Tremenheere, Maj.-Gen.), xvii. 537.
- Irrigation, in India, (Tremenheere, Maj.-Gen.), xvii. 485. *Vide also* PUBLIC WORKS, India.
- Katwyk. "The history of the canal of Katwyk, Holland, with a description of the principal works." By the Chevalier F. W. Conrad. Translated by C. Manby, ii. (1842) 172.
- Lockage for, new system of, (Smith, J., of Deanston), i. (1840), 53.
- Marseilles, (Rennie, G.), xiv. 190; (Pole, W.), 202. *Vide also* AQUEDUCTS, Roquefavour.
- Newry, to Fathom, recommended by the Irish Board of Inland Navigation, in 1760, (Rennie, Sir J.), x. 281.
- Oegstgeest, Holland, (Conrad, F. W.), ii. (1842) 175.
- Old Croydon. Difficulties caused by the London clay, (Rennie, Sir J.), iv. 85.
- Tame Valley, labour of horses upon (Horne, J.), ii. (1843), 118.
- Tavistock, tunnel on, (Taylor, J.), iii. 150.
- Terneuse, (Cubitt, Sir W.), vi. 112; (Rennie, G.), 113.—Principal dimensions of ditto, 114.—Description of the course of ditto, 114.—Gates and other works of ditto, 114.
- Traction, horse power employed and force of, upon the Grand Junction canal, (Rennie, G.), ii. (1843), 115.
- Ulster. "Description of a portion of the works of the Ulster canal." By T. Casebourne, ii. (1842), 52.
- Vide also* BOATS, CANAL INCLINE PLANES, and CANAL LIFTS.
- , versus railways, as a means of conveyance, and as to instances of their working in competition and in co-operation, in reference particularly to

CARPMAEL.

- the metropolis (Stephenson, R.), xvii. 406.
- Cannabic composition, for architectural decoration, iii. 70.
- Cannon. *Vide* ARTILLERY.
- CANTWELL, R. [Election, i. (1841) 168; memoir, xix. 186.]
- Caoutchouc. *Vide* INDIA RUBBER.
- Capitol of the United States, xviii. 180.
- CAPPER, C. H. [Election, i. (1838) 12.]
- Caps, detonating, mode of placing on the nipple, xiv. 189.
- Carbon combined with iron in the ore, ii. (1842) 61.—Deposited from brewer's wort, ii. (1843) 170.—The state in which carbon exists in iron governs its corrodibility, 173.—Mode of determining the amount contained in cast iron, 178.—Quantity contained in coal-gas, oil, &c., and evolved during combustion, 185.
- Carbonic acid produced by the combustion of oil and coal-gas, ii. (1843) 185, 206.—Fatal to human life, 185.—Action of, upon respiration, 185.—Proportion of, in the confined air of inhabited rooms, 185.—Found to be injurious to health, 186, 206.—Tests for detecting the presence of, 188.—Connection with the circulation of the blood, 190.—Opinions of Hall, Davy, Graham, and Edwards upon, 190, 191.—Presence of a certain portion of, essential to regulate the circulation of the blood, 191.—Action of Dr. Payenne's apparatus upon, 191.
- CARLETON, F. [Election, iv. 291; memoir, viii. 14.]
- CARMICHAEL, P.
- Water-meter. "Description of a water-meter," iii. 68.
- CARNEGIE, Captain W. F. L. [Memoir, xx. 160.]
- Machine, notice of Hunter's stone-planing, i. (1837) 38.
- CARPENTER, H.
- Chronometric governor, application of Messrs. Siemens', to his corn mills at Shad Thames, v. 262.
- CARPMAEL, W., [Member of Council, i. (1838) 20.]

CARR.

Iron and steel. Case-hardening, i. (1839) 30.—Experiments on the strength of Ystalyfera and Yniachedwyn iron, ii. (1843) 131.

Locks and keys. As to the picking of Mr. Hobbs' protector lock, xiii. 269.

Patents. Assertion that no practical invention ever failed for want of capital, x. 213.—As to the appointment of a registrar, or board, to revise specifications, 214.

Railways. Worsdale's apparatus for exchanging letter-bags on railways, when the train is in motion, i. (1838) 32.

Stone, artificial, with a silica base, vii. 70.

CARR, H. [Election, i. (1838) 5; Council premium, xi. 87, 119.]

Bridges. "Description of two bridges over the river Don and the canal, with the lodge and approaches, on the estate of Sir Joseph Copley, Bart., at Sprotbro', near Doncaster," x. 302.—Remarks, 306.

Cuttings and embankments. "Description of an instrument for setting out the width of cuttings and embankments of railways, canals, or roads, as particularly applicable to falling, or side-lying ground," i. (1839) 52.

Dynamometer. "Description of a dynamometer, or an instrument for measuring the friction on roads, railways, canals, &c.," i. (1840) 52.

Permanent way. His railway crossing, xiii. 437.—Railway switches and crossings, xiv. 432.—Cost of maintenance of permanent way, 440.—Relation of tonnage to maintenance, 441.

Railways, importance of attention to the relative gauges of the line and the rolling stock on, xvi. 294.

Surveying instruments. "Description of an instrument for describing the profile of roads," i. (1840) 56.

CARR, M. W. [Election, xx. 191.]

Carriage stock of railway companies, xi. 444. *Vide also RAILWAY ACCIDENTS.*

CARRINGTON, F. A.

Models, in relief, of portions of the counties of Lancashire, Yorkshire, &c., viii. 330.

CAWLEY.

Carron foundry, reputation of the cannons cast there due to the care in selecting the metal, ii. (1843) 133.—Method of proving iron at the, 133.

CARTER, R. [Election, xiv. 491.]

Carving, dental, description of Tomes' machine for, iv. 250.

CASEBOURNE, T. [Telford premium, ii. (1843) 6.]

Blasting under-water. "Description of a raft, or float, used for submarine blasting, on the works of the West Hartlepool harbour and docks," x. 293.

Canal. "Description of a portion of the works of the Ulster canal." ii. (1842) 52.

Case-hardening, i. (1839) 30.

Casks used for floating large stones to construct sea walls in deep water (Brenner, J.), iii. 122.

—, manufacture of, by machinery, xvii. 87.

Cast iron. *Vide IRON.*

Cast steel. *Vide IRON AND STEEL.*

CASTEL, M., and D'AUBUISSON.

Water, discharge of, experiments by overfalls at the Toulouse water-works (Blackwell, T. E.), x. 332.

CASTLE, H. J. [Election, vi. 254.]

Catch, new form of, used on the Birmingham and Gloucester railway, ii. (1843) 105.

Cattle markets of Paris, viii. 68.—Proposed at Islington, 77.—Of London, 78, 79. *Vide also ABATTOIRS.*

CAUSTON, A. [Election, v. 840.]

CAWLEY, O. E. [Election, v. 478.]

Drainage of towns. Substitution of pipe-drains, made of fire-clay, for all sewers of less than 2 feet diameter, at Manchester, xii. 79.—Extract from a letter from Mr. J. Francis, as to the state of the pipe-drains at Manchester, 80.

Permanent way. As to rails on Lancashire and Yorkshire railway, xi. 477.

Roads. Comparative cost of macadamizing Albert Place, and of paving Albert bridge, Manchester, xiii. 230, 231.

Water, discharge of, gaugings, x. 331.—Results of a series of experiments on the, by overfalls, or weirs, 352.

CAYLEY.

CAYLEY, Sir G., Bart. [Election, i. (1838) 38; memoir, xviii. 203.]

Air-engines. Stirling's air-engine, iv. 358.

— "On the use of heated air as a motive power," xii. 332.

Drainage of land. Muston drainage, near Scarborough, iv. 209.

Cayley's (Sir G.) hot-air engine, (Poingdestre, W. W.), ix. 194.

Cedar, white, for railway sleepers (Churhill, —), i. (1840) 44.

Cement, a preventive of corrosion, i. (1839), 37.

CEMENTS.

Experiments on, (Pasley, Sir C. W.), i. (1837) 17.—Various kinds of artificial, (Price, H. H.), 19.—Formation of, (Lowe, G.), 19; (Bramah, F.), 20; (Hawkins, J. I.), 20.—Lime in the neighbourhood of Plymouth (Stuart, W.), i. (1838), 35.—Roman cement (Rennie, Sir J.), v. 35.

— "Observations on artificial hydraulic, or Portland cement, with an account of the testing of the brick beam erected at the Great Exhibition, Hyde Park." By G. F. White, xi. 478.—Properties of natural hydraulic cements, 479.—Experiments as to manufacture of artificial hydraulic cement, 480.—Process employed in the manufacture of Portland cement, 481.—Progressive increase in the strength of the cement, 481.—Mixture of cement with lime mortar, 482.—M. Vicat's opinion of Portland cement, 484.—Agency to which cements owe their power of setting, 484.—Ditto lime owes its ditto, 485.—Uses of Portland cement as concrete, mortar, and stucco, 485.—Employment of Portland cement for concrete blocks, 486.—Ditto at Dover, 486.—Ditto at Alderney, 487.—Ditto at Cherbourg, 488.—Material called 'artificial granite,' 490.—Experiments on adhesion, both of Portland and Roman cements, 491.—Brick beam erected at Great Exhibition, for testing the comparative strength of Portland and Roman ce-

CHADWICK.

ment, 492.—Dimensions of ditto, 493.—Experiments as to strength of ditto, 494.—Application of Portland cement as stucco, 496.—Appendix: Experiments on the relative resistance to compression of Portland and Roman cement, 497.—Ditto on compression on blocks of pure cement, 498.—Ditto on the relative adhesive powers of Portland and Roman cement, 499.—Ditto on the cohesive power of Portland cement and Portland stone, 500.—Ditto on the resistance to cross strain, tried on beams of pure cement, 501.—Memoranda with reference to Portland cement, &c., 501.—Amount of absorption by different substances, 502.

Discussion.—Fitzroy, Admiral, 505.—Francis, J., 505.—Gibbs, J., 504.—Gravatt, W. 504.—Hawkshaw, J., 503.—Hopkins, J. D., 504.—Locke, J., 505.—Pasley, Lieut.-Gen. Sir C. W., 502.—Rendel, J. M., 510.—White, G. F., 504, 505.

Theory of the action of lime (Rennie, G.), xvi. 427.—Calcination of cements at a high temperature, especially as to the material known as Portland cement (White, G. F.), xvii. 435.—Ultimate induration of Portland cement, 437.—As to whether the presence of iron, in combination with limes and cements, promotes their 'hydraulicity,' 437.

Vide also CONCRETE AND RUBBLE BÉTON; and MORTAR, Hydraulic.

Centering. *Vide* ARCHES, and BRIDGES.

CHADWICK, D. [Election, xiii. 475; Council premium, xiv. 105.]

India-rubber, as to the question of the chemical, or mechanical change in vulcanized, from immersion in water, xiii. 436.

Water-meters. "On water-meters," xiii. 421.

— Rotary water-meter, xvi. 64.

CHADWICK, E.

Abattoirs. As to the butchers' trade in England, and the advantages to be derived from the establishment of abat-

CHADWICK.

toirs similar to those of Paris, viii. 74.

Sewage. Application of liquid manure on the Mansfield meadows, and on some land near Edinburgh, vii. 95. —Want of resemblance between the produce of the sewers of London and Edinburgh, 96. —Value of liquid manure, 96. —Presumed exhalations arising from the application of liquid manure, 96. —Results from this mode of manuring, 97. —Expense of the distribution of liquid manure, 97.

Street-cleansing, advantages of mechanical, vi. 455.

CHADWICK, W. [Election, i. (1841) 80.]

Chain-cable and timber-testing machines, (Dunn, T.), xvi. 301.

Chairs. *Vide* PERMANENT WAY.

CHALK.

Absorbent power of. "On the absorbent power of chalk, and its water contents, under different conditions." By Prof. D. T. Ansted, ix. 360. —Statement of the geological character of this rock, 360. —Area of country over which it extends, 360. —Its position, 361. —Subdivisions of the chalk, 361. —Experiments on the position and relative absorbent powers of different kinds of chalk, 362. —Porosity of this rock, 364. —Conclusions to be drawn from the experiments, 366. —Extent of surface of exposed chalk, 367. —Appendix, tabular details of experiments, 368.

Discussion.—Ansted, Prof., 369, 374. —Barlow, P. W., 373. —Braithwaite, F., 369. —Dickinson, J., 369, 374. —Hawkshaw, J., 373. —Mantell, Dr., 371.

Absorbent power of, (Clutterbuck, Rev. J. C.), xiv. 66; (Gibbs, J.), xx. 213.

Degradation of chalk cliffs (Homeraham, S. C.), xi. 219; (Deane, —), 219.

Puddle made from, (Palmer, H. R.), ii. (1842) 163.

Vide also LONDON BASIN, WATER SUPPLY, and WELLS.

Chalk basin of London, periodical drainage and replenishment of, (Clutterbuck, Rev. J. C.), ii. (1842) 155; (1843)

CHESIL BANK.

156; ix. 151. *Vide* also CHALK, LONDON BASIN, WATER SUPPLY, and WELLS.

CHALMERS, A.

Railway breaks. Results of the application of a continuous break on the North London railway, xix. 524.

CHALMERS, Colonel, R.A.

Fire-arms. Practice with Colt's revolvers, xi. 58.

CHALMERS, T. [Election, i. (1839) 46; Walker premium, ii. (1843) 7.]

CHAPMAN, H. [Election, i. (1840) 22; Telford medal and premium, i. (1841) 9.]

Surveying instruments. "Description of an instrument for describing the profile of roads," i. (1840) 86.

CHAPMAN, Lieutenant W., B. E. [Election, xi. 478; memoir, xiv. 167.]

CHAPMAN, W.

Coal-drops, inventor of the, with vibrating frames, in use on the Tyne (Turnbull, G.) v. 252.

Locomotive engine, his patent for a, (Rennie, Sir J.), v. 70.

Professional MSS., his, presented to the Institution, i. (1837) 87.

River Orwell and Port of Ipswich, extracts from his reports of 1797 and 1803 (Hurwood, G.), xx. 5 *et seq.*

CHAPPÉ, T. F. [Election, xvi. 226.]

Arches. "Account of experiments upon elliptical cast-iron arches," xviii. 349. —Remarks, 359, 362.

CHAPPEL, Captain E., R.N. [Election, i. (1840) 22.]

Charcoal, method of preparing, i. (1838) 15. —Various qualities of, i. (1839) 31.

Charts, contouring and colouring, so as to represent the different depths of the sea, vi. 128; xx. 314, 341, 347, 374.

—, wind and current, xiv. 383, 410.

CHEFFINS, C. F. [Election, vii. 336.]

Chelsea hospital, precautions against fire, and the supply of water, iii. 322.

Chelson meadow sluice (Budd, T.), ii. (1842) 62.

Chemistry connected with manufactures, vi. 25.

CHESIL BANK.

"Description of the Chesil bank, with

CHESNEY.

remarks upon its origin, the causes which have contributed to its formation, and upon the movement of shingle generally." By J. Coode, xii. 520.—Description of the bank as it is at present, 524.—Past condition, according to Leland, Camden, Smeaton, and others, 524.—Origin, or source from which the shingle is derived, 526.—Causes which have contributed to the formation of the bank, 528.—Progress of the shingle not attributable to the action of the tidal currents, but to the effect of the wind-waves, 530.—Prevalence of west and south-west winds in this latitude, 530.—Form of the bank, 532.—Disposition of the shingle, 536.—Recapitulation of the chief points noticed in the Paper, 541.—Violence of the sea breaking upon the bank during heavy gales of wind from the south-west, 544.—Changes which take place from time to time upon the bank, 544.—Appendix A. Sloop 'Ebenezer' ran directly on the bank when unable to 'weather' Portland, and was launched into Portland Roads, 545.—Ditto B. Description of the boats called 'ferrets,' 545.

Discussion.—Airy, Prof., 554.—Babbage, C., 547.—Bidder, G. P., 547.—Coode, J., 547, 554, 555.—Fitzroy, Admiral, 553.—Gibbs, J., 551.—Hawkshaw, J., 550.—Murray, J., 550.—Rendel, J. M., 557.—Rennie, G., 552.—Rennie, Sir J., 549.

Vide also COASTS, English, South; and SHINGLE.

CHESNEY, Colonel.

Isthmus of Suez. Extract from his report of an examination of the country between the Mediterranean and the Red Sea, particularly as to the coast and the lake Menzaleh (Glynn, J.), x. 37.

CHEYVERTON, B. [Telford medal, xiii. 127.]
Air engines. "On the use of heated air as a motive power," xii. 312.

CHEYNE, C. [Election, xvi. 46.]

CHILDREN, J. G. [Election, i. (1838) 51; memoir, xii. 137.]

CHRONOMETERS.

CHIMNEYS.

Building and repairing, scaffolding for, (Journet, P.), iii. 218.—Method of repairing Messrs. Couper's chimney, Glasgow (Colthurst, J.), 223. *Vide also* SCAFFOLDING.

Dimensions of, proportional to steam boilers, (Murray, A.), iii. 341.

Number of shafts erected in the metropolitan districts from 1845 to 1853 (Poynter, A.), xiii. 413. *Vide also* SMOKE, Prevention of.

Weight on the bases of some high brick, (Cowper, C.), x. 242.

CHISHOLM, J. [Election, ii. (1843) 155; memoir, xvi. 121.]

Chlorine, effect of, in the preservation of timber and paper, ii. (1842) 85.

Chloroform-engine. Combined-vapour engine, on M. Du Trembley's system, worked by chloroform, xviii. 260.

Cholera, report by the Registrar-General on, in England, xii. 27.

Chorley-road bridge, ii. (1842) 179.

Christiania, natural harbour, or 'Fiord,' at, xv. 239.

CHRISTY, F. C. [Election, vi. 134.]

CHRONOMETERS.

"On the laws of isochronism of the balance spring, as connected with the higher order of adjustments of watches and chronometers." By C. Frodsham, vi. 224.—On the present state of knowledge of the science of horology, 224.—Investigation of the principles of the isochronal adjustment, 225.—Example illustrative of the effects of a non-isochronal spring upon an otherwise good watch, 225.—The inventions and improvements of Dr. Hooke, in watches and clocks, 226.—The cylindrical form of balance-spring and compensation balance invented by Arnold, 227.—On the discovery of isochronism in France, 227.—Experiments made by Berthoud to ascertain the variations of rate due to changes of temperature, 228.—Extract from an essay by Bernouilli, read before the French Academy, on the diminution of elastic force in balance-springs by heat, 228.

CHUBB.

- On the nature of isochronism, 229.
- On the elastic force of balance-springs, 229.—The specific conditions under which the vibrations of the balance should be isochronous, 231.—On the material for balance-springs, 232.—On the elasticity of ditto, 233.—On the helical, or cylindrical form of spring, 233.—Mode of testing the isochronism of a spring in a chronometer, 234.—Rules for the correction of errors, when the chronometer is found to lose in the long arcs, and when it is found to gain in the long arcs, 234.—The opinion of early writers upon isochronism, 235.—On the spiral, or flat spring, 235.—On the isochronal trial of a flat spring in a watch, 237.—On the advantages of an isochronal spring, 237.—Mode by which an isochronal spring arrives at perfection, 238.
- Discussion.—Farey, J., 239, 248.—Frods-ham, C., 251.—Vulliamy, B. L., 246.
- Chronometric governor by Messrs. E. W. and C. W. Siemens, v. 255.
- CHUBB, C.
- Locks and keys. Picking Mr. Hobbs' protector-lock, xiii. 270.
- CHUBB, J. [Election, viii. 206; Telford medal, x. 65.]
- Iron safes and chests. Iron-chest for the transmission of money and valuables on railways, vii. 185.—Construction of strong rooms and fire-proof safes, and the proper position for iron safes, viii. 154.—Fire-proof safes and chests, ix. 329.
- Locks and keys. "On the construction of locks and keys," ix. 310.—Remarks, 328.—Means for securing bankers' safes, 328.—Burglar's instrument, called a 'Jack-in-the-Box,' and means to prevent its operation, 330.—Number of locks which might be made in series, 335.—Davis' lock, 337.—Parsons' lock, 337.—Williams' lock, 337.—Nettle-fold's lock, 337.—Difficulty of picking a Chubb lock, 338.—Locks of Millbank and Pentonville prisons, 340.—Manufacture of locks, 343.

CLARK.

- Chubb's detector-lock, patented in 1818, xiii. 258.
- CHURCH, Dr.
- Axles, hollow (Newton, W.), ii. (1843) 94.
- CHURCH, J. [Election, xiii. 241.]
- Gas. "On the results of the use of clay retorts for gas-making," xvi. 300.—Remarks, 325.
- CHURCHILL, —.
- Timber. "On a specimen of white cedar from Bathurst, New Brunswick," i. (1840) 44.
- CHURCHILL, J. F. [Election, xvii. 195.]
- CHURCHWARD, W. H. [Election, x. 369.]
- Cinder produced by Clay's process of iron-making, superior in quality and free from phosphoric acid, ii. (1843) 83.
- CINI, T. [Election, vi. 481; memoir, xii. 151.]
- Civil Engineering. Increasing importance of the profession, i. (1839) 16.—Connection between geology and civil engineering, i. (1840) 36.—Retrospective view of the civil engineering of Great Britain, v. 19.—The most important works in, executed during the latter half of the last century, 24.—Connection between theory and practice, 116.—Works of celebrated foreign engineers, 117.—Prospects and duties of civil engineers, 118.—State of the profession in America and England, xi. 64.—Cursorial review of the works upon which civil engineers have been engaged, 150.
- Clacks for pumps, ii. (1842) 171.—Fish head for drawing a drowned clack, 171.
- CLACY, J. B. [Election, vi. 297.]
- CLANNY, Dr.
- Mines, safety-lamp for, (Richardson, J.), vi. 165.
- CLARK, C. [Election, ix. 375.]
- CLARK, D. K. [Election, xiii. 241; Telford medal, xiii. 126; xvii. 80; Council premium, xiv. 105; xx. 122, 170.]
- Locomotive boilers. "Experimental investigation of the principles of the boilers of locomotive engines," xii. 382.—Remarks, 414.—Manner of arriving at conclusion, that 1lb. of carbon is capable of evaporating

CLARK.

12 lbs. of water into steam, 423.—Formula derived directly from tabulated results, 423.—Mr. McConnell's new engine, 424.—Proof of practically complete combustion of coke in the fire-box, 427.—Result of a recent experiment in reducing the area of the fire-grate, 428.—Curve of expansion in locomotives, 598.

— Higher pressure at which they are now worked, xv. 39.

Locomotive engines. Chief cause of the fracture in the driving-axes of locomotives, xiii. 469.—Question of precedence in the application of the cranked axle to locomotive engines, xvi. 25.—Economy of fuel resulting from the correct equilibration of four goods'-engines on the South-Western railway, 26.—Ditto two passenger-engines on the Cork and Bandon railway, 26.—Economy by heating the feed-water, 26.—Relative cost of coke and coal as fuel for locomotives, 27.—Comparative evaporative efficiency of coal and coke, 30.—First public assertion of the principle of complete equilibration of locomotives, 39.—Mr. Crampton's conclusions as to the requirements of locomotives, 39.

— "On coal-burning and feed-water heating in locomotive engines," xix. 546.—Remarks, 564, 566.—Comparative cost of coke and coal, 583.—Mr. Jenkins' apparatus for burning coal in locomotives, as employed on the Lancashire and Yorkshire, and as to the performances of the system on the Brighton railway, 584.

Locomotive stock. "On the improvement of railway locomotive stock, and the reduction of the working expenses," xv. 496; xvi. 3.—Remarks, 25.

Railway trains, resistances to, especially on steep gradients and sharp curves, xviii. 65.

Ruthven's propeller. "An account of the deep-sea fishing-steamer, 'Enterprise,' with Ruthven's propeller," xiii. 370.

Safety-valves, principles of, xv. 38.

CLARK.

Volute springs for buffers and carriages, xv. 39.

CLARK, Dr. T.

Water. Description of his process for softening chalk water (Ansted, Professor), xiv. 59.

CLARK, E. [Election, x. 57.]

Bridges, suspension, disturbances of, and modes of counteracting them, xvi. 477.

Electric telegraph, and whether the over-ground, or the underground system of wires was to be preferred, xi. 369.—Objections to lead covering for underground telegraph wires, 378.

Girders, middle webs of iron, xv. 192.

Ships, new mode of lifting, introduced by him (Annual Report) xviii. 171.

Telegraph cables between England and Holland, xx. 88.

CLARK, J. L. [Election, xvii. 410.]

Electric telegraph, application of, to railway semaphores, xi. 378.—Bain's printing telegraph, 378.—Experiments as to the passage of electricity through underground wires (Window, F. R.), xvi. 198, *et seq.*—Ditto with varying battery powers to ascertain the velocity of electric currents, 211.

Telegraph cables. Means of overcoming the effects of the induced currents in submarine wires, by machines invented by Mr. Henley, Mr. Window, and Mr. Varley, xvi. 212.—Method of overcoming the difficulty arising from the inequality of the currents, 212.—System of using alternate currents, or waves of positive and negative electricity, 213.—Submerging, particularly as to the use of floats, or resistors, xvii. 310.—His recommendations to the Atlantic Telegraph Company, 313.—Comparative advantages of light and heavy cables, and cable proposed by Mr. Allan, 313.—Submarine cables for shallow water, xx. 62.—Greater durability of galvanized, as compared with unprotected iron cables, 62.—Cable between Hurst Castle and the Isle of Wight, 63.—Atlantic and the Red Sea cables, and the causes of their failure,

CLARK.

- 63.—Paying out cables, 64.—Red Sea and Indian telegraph cables, and cable between England and Holland, 68.
- CLARK, T. [Election, i. (1841) 168; memoir, xvii. 96.]
 Blasting under water in well-sinking, x. 295.
 Piles, effect of drawing, from a clay soil, ix. 14.
 Water-level, depression of, under London, ix. 179.
 Water supply, derived from the chalk, for the locomotive engines on the London and North-Western railway, viii. 176.
 Wells, use of the 'miser' in sinking, ii. (1842) 192; (1843) 59.—Temperature of water in wells, 142.—Water from the chalk and sand, and on wells near London, 165.—Sinking cylinders for, iii. 201.—Blasting under water in well sinking, x. 295.
- CLARK, W. T. [Member of Council, ii. (1842) 51; (1843) 67; iii. 66; memoir, xii. 153.]
 Foundations, under water, formation of artificial, iv. 248.
- CLARKE, ——.
 Screw piles and their uses, vii. 144.
- CLARKE, H.
 Engineering works of Holland, compared with analogous works in England, vi. 112.
 Sea defences, construction of, especially in Holland, vi. 118.—Forms of beaches give the best outline for sea defences, 131.
- CLARKE, J. A. [Election, xii. 432.]
 CLARKE, J. W. [Election, xix. 461.]
- CLAXTON, Captain R.N. [Election, xi. 241.]
 Steam navigation, &c. Steamers and sailing-ships, between England and Australia, xiv. 396.—Ships building for Liverpool and Australian Navigation Company, 397.
- Clay, pottery, composition and uses of, ii. (1843) 149.
- Clay retorts, for gas-making (Church, J.), xvi. 309.
- CLAY, W.
 Artillery, construction of, and as to the

CLIFF.

- Mersey Company's large forged gun, xix. 359.—As to preventing the over-running of the shot in the bore of a gun, xx. 487.
- Iron and steel. Wrought iron in large masses, xviii. 333.—Puddled steel, and experiments for ascertaining the strength and safe elastic limit of that material, 337, 343.—Cause of internal rents in large forgings, 340.
- CLAY, W. N.
 Glass, true atomic character of, iii. 232.
 Iron ores, process of smelting hæmatite, iii. 226.
 ——"On the iron ore, or iron sand of Samakoff, in Turkey, and on the best means of reducing it into the states of cast and wrought iron, &c.," iii. 230.
 Iron, wrought. "Description of Mr. Clay's new process for making wrought iron direct from the ore, as practised at the Shirva works, Kirkintilloch, Scotland," ii. (1843) 82.—Remarks, 84, 86.
- CLEGG, S.
 Meters. "On the dry meter," i. (1838) 14.
 Railway, atmospheric, (Samuda, J.), iii. 264.—Valve with composition joints, 271.
- CLEGG, S., Jun. [Walker premium, ii. (1842) 9; election, vii. 184; Telford medal, xi. 87, 118; memoir, xvi. 121.]
 Aqueduct at Lisbon. "Description of the great aqueduct at Lisbon, over the valley of Alcantra," i. (1841) 138.
 ———, xiv. 211.
 Arches, materials for, and mode of building piers and arches, x. 300.
 Foundations. "On foundations, natural and artificial," x. 317.—Remarks, 320.
 Gas. Extract from a treatise by him, as to Mr. Grafton's fire-clay retorts for gas-making (Church, J.), xvi. 310.
 London basin, depression of water-level in the chalk of the, xiv. 68, 84.
- CLEGHAM, W. B. [Election, viii. 206.]
- CLEWSON and ROGERS.
 Gold district of Virginia, U.S. (Hopkins, E.), xv. 69.
- CLIFF, J.
 Pipes, large-sized, or tubes, made at the Wortley Fire-brick Works, xii. 78.

CLIFFORD.

CLIFFORD, C.

Boats, his system of lowering, xiv. 418.

Clinometer, Grantham's (R. B.), improved, v. 480.

—, prismatic, for measuring vertical angles, (Pole, W.), xi. 23.

Clock, made by Tompion in 1670, vi. 495.

Clocks for railway stations, on the construction and regulation of, (Vulliamy, B. L.), iv. 63.

—, successive improvements in, v. 105.

—By Graham, 106.—Ditto the scape-ment, 106.

CLUTTERBUCK, Rev. J. C. [Telford medal, x. 65.]

Chalk, absorbent power of, xiv. 66.

London basin. "Observations on the periodical drainage and replenishment of the subterraneous reservoir in the chalk basin of London," ii. (1842) 155; (1843), 156.—Remarks, 161.—Results of rain gauges, 161.—Identity of the sand and chalk water-levels, 163, 164.—Water-bearing strata of the London basin, xiv. 66.

Railway cuttings, drainage, &c., iii. 154, 171.

River Thames, perennial flow of the, xv. 227.

Water supply. "On the periodical alternations, and progressive permanent depression, of the chalk water-level under London," ix. 151.—Remarks, 155.—Outfall of the chalk waters, 155.—Depression of the water-level by pumping, 155.—Supposed identity in the chalk waters, 163.—Experimental well in Bushey Meadows, 163.—Wells upon the sea-coast tidal, 170.—Possibility of obtaining a supply of water for London from the chalk district around Watford, 171.—Springs issuing in the valley of the Colne, 172.—Supply of water to, and on the chalk-water level under, London, 180.

— Absorbent power of chalk, xiv. 66.—Indications by Dalton's rain-gauge, 67.—Assumed possibility of drawing water from wells, or shafts in the chalk, 68.—Probability of infiltration of tidal waters to water under

COAL.

London, 510.—Present level of chalk water, 511.—Supply of water to be obtained from wells sunk in the chalk and sand formations, and as to the general depression of the water-level under London, xix. 30, 37, 45, 49.

Wells at Epping and Tottenham, &c., ii. (1842) 163.—Tidal water in wells at London, Ramsgate, Portsmouth, and Liverpool, xix. 32.—Water from the chalk at Brighton, 47.

CLUTTON, H. [Election, iii. 248; resignation, xv. 85.]

CLUTTON, J. [Election, i. (1840) 31; Member of Council, vii. 56.]

Drainage of land. Effects of an obstruction to the drainage of a district near Maldon, xix. 88.—Arterial drainage works in Ireland, 89.

CLUTTON, W. J.

Drainage of land. Difficulties in draining large areas of land for farming purposes, owing to the want of compulsory powers for dealing with the outfalls, xix. 113.

Clyde, vale of, semifluid mud found in sinking wells, ii. (1843) 137.

— river, water of, holds in suspension colouring matter from peat mosses, ii. (1843), 137.—Requires slow filtration, 137.—Precipitation accelerated by a mixture of pipe-clay, &c., 137.

COAL.

Heating effect of, as compared with coke, (Parke, J.), i. (1838) 29.—Relative heating powers of coal and coke in melting glass (Pellatt, A.), 39.—Comparative mechanical values of coal and coke (Clark, D. K.), xvi. 6.—Relative cost of, as fuel for locomotives, 27.—Relative evaporative power (Longridge, J. A.), xix. 568 *et seq.*

Properties and chemical constitution of. "On the properties and chemical constitution of coal, with remarks on the methods of increasing its calorific effect, and preventing the loss which occurs during its combustion." By C. Hood, i. (1840) 62.—The combustion of coal, 63.—Application of the volatile products of coal, 66.

COAL.

Discussion.—Field, J., 67.—Parkes, J., 66.—Pellatt, A., 67.

Quality and heating powers of, as used with Cornish engines (Wicksteed, T.), i. (1838) 6.—Quantity used per horse power (Farey, J.), 8.

Shipment of. *Vide* COAL DROPS, and DOCKS.

Sinking shafts in, system pursued in opening a bed underlying a quicksand, 65 feet thick, near the banks of the river Loire (Hughes, J.), x. 361.

South-eastern Africa, specimens of coal from, (Sowerby, W.), xvi. 84.

South Wales. "The coal-field and the coal of South Wales." By J. Richardson, viii. 82.—Benefits arising from a plentiful supply of good coal, 82.—Utility and power of fire and water, 82.—Causes tending to augment the present consumption of coal, 82.—Estimates of the probable duration of the supply to be derived from the great northern coal-field, 83.—Increase in the home consumption and in the shipments from this district during the present century, 83.—Progressive exhaustion of, and demand on, the Staffordshire, Derbyshire, Yorkshire, and Lancashire coal-fields, 84.—Inquiry as to other sources of supply, 84.—Coal deposit in South Wales, 84.—Area and localities of this coal-field, 85.—Recapitulation of the areas in each county, and of the whole coal-field, 87.—Average depth, or thickness of the coal, 87.—Two deposits of coal in this field, 87.—Statement of the number and thickness of the veins of coal in the upper and lower series, 88.—Mr. Martin's estimate of the area and thickness of the workable coal, 88.—Sources of demand on this coal-field in sustaining the manufactures of metals, &c., 89.—Quantity used in the smelting and manufacture of iron, 89.—Ditto in copper-smelting, 90.—Ditto in the manufacture of tin plates, 90.—Ditto in the chemical and other works, and for domestic purposes, 90.—Increase in the shipments, and account

COAL.

of the shipments of coal, culm, and cinders from South Wales, in the year 1847, 90.—Recapitulation of the quantities of coal now annually consumed, and the estimated value of the manufactures in the production of which it is employed, 91.—Quality of the coal of South Wales, and great variety in the fuel, 92.—Fitness for the smelting and manufacture of metals, 93.—Ditto for the production of steam, 93.—Value of coal for producing steam, 93.—Table showing the number of pounds of water evaporated from 212° by one pound of different kinds of coal, and the mean composition of the average samples, with remarks thereon, 94.—Kind and quality of the fuel to be used should be considered in designing furnaces and boilers, 96.—Fitness of the coal of South Wales for other manufacturing purposes, and for household and other miscellaneous uses, 97.—Analyses of the different classes of coal, 98.—The bituminous, 98.—The semi-bituminous, 99.—The partially-bituminous, 100.—The anthracituous, 100.—The anthracite, 100.—Recapitulation of the foregoing analyses, 100.—Kind, quality, and quantity of coke produced from these different coals, 101.—Kind and quality of the coke used in locomotive engines should receive more consideration, 102.—Use of anthracite in locomotive engines and in steam-ships, 103.—Experiments with a conglomerate coke formed of small anthracite and the small of bituminous coal, 104.—Present price of anthracite, 104.—Analyses of coal from different localities, 105.—Evaporative power of ditto, 105.—Mode and cost of obtaining the coal of South Wales, 106.—Facilities of conveyance from the collieries to the places of consumption, 107.—Present prices of the coal, 108.—Appendix, Table of the coal produced in Great Britain and Ireland during the year 1855, 109.

Discussion.—Enys, J. S. 114.—Glynn, J., 113, 115.—Gooch, D., 110.—Harding,

COAL DROPS.

W., 112.—Playfair, Dr. L., 114.—Stephenson, R., 110, 113.—Woods, E., 112, 113.

Weight of a bushel of, (Lowe, G.), i. (1838) 3; (Price,—), 3; (Wicksteed, T.), 3.

Vide also ANTHRACITE; COAL DROPS; COAL MINES; FUEL; LOCOMOTIVE BOILERS; LOCOMOTIVE ENGINES; STEAM BOILERS; and STEAM ENGINES.

Coal burning and feed-water heating in locomotive engines (Clark, D. K.) xix. 546. *Vide also* LOCOMOTIVE ENGINES.

COAL DROPS.

Middlesbro'-on-Tees. "Account of the drops used for the shipment of coals at Middlesbro'-on-Tees, with a short description of the town and port of Middlesbro'." By G. Turnbull, v. 248.—Situation of the town, with the population returns, 249.—Opening of a branch railway from the Stockton and Darlington railway, 249.—Returns of the quantities of coals shipped between the years 1825 and 1841, 249.—New town created by the Middlesbro' Company, 250.—Mode of shipping the coals between the years 1830 and 1842, 250.—The dock, 250.—The entrance lock to the dock, 251.—The branch railway to the dock, 251.—Cost of the foregoing, 251.—The drops, and their cost, 252.—Statement of the work performed by the drops, 253.—Appendix, containing an account of the quantity of coals shipped at the Port of Middlesbro'-on-Tees, from June, 1841, to December, 1845, 254.—Ditto of the number of vessels that entered the dock, and departed with cargoes, from May, 1842, to the end of 1844, 254.

South Shields, (Harrison, T. E.), i. (1837) 37.

Vide also DOCKS.

Coal Fields. Areas and production of, in 1853, in different parts of the world, and in the United Kingdom, (Allen, E. E.), xiv. 343.

—Forest of Dean, i. (1840) 49.

—Midlothian, v. 338.—Its want of drainage, 339.—Table of the seams

COAL MINES.

existing in the New Craighall engine pit, 339.

Coal Fields. North of England, ii. (1842) 170.

—South-Western of England, ii. (1842) 139.

—*Vide also* COAL, and COAL MINES.

COAL MINES.

Accidents in, (Farey, J.), viii. 136.

Explosions in. "On the explosion of fire-damp which occurred in the Eaglesbush, or Eakyn colliery, near Neath, South Wales, on the 29th of March, 1848." By J. Richardson, viii. 118.—Description of the colliery and works, 120.—The ventilation, 121.—State of the mine before the explosion occurred, 122.—Lights used in the mine, 124.—State of the mine at the time of the inspection, after the accident, 124.—Culvert and chimney for improving the ventilation, and experiments to ascertain the temperature of the air at different points, 126.—Expedient resorted to for ascertaining the velocity of the air in the mine, 127.—Probable causes of the accident, 128.—Best known means of preventing the recurrence of explosions, 128.—Mr. W. P. Struvé's mine-ventilator, 129.

Discussion.—Brunel, I. K., 134.—Farey, J., 136.—Glynn, J., 183, 184, 185.—Manby, C., 137.—Smyth, W., 129, 134.—Stephenson, R., 136.—Taylor, —, 134.

Explosions in. "A comparative view of the recorded explosions in coal mines." By W. West, x. 1.—Appointment of inspectors of coal-mines, 1.—Necessity for good ventilation, 3.—Limit to quantity of air conveyed to a certain extent of workings, 3.—Additional security by splitting the body of fresh air, 4, 9.—No record of any explosion caused by ignition of foul air at the furnace, 4.—Division of interests, of authority, and of responsibility, very unfavourable, 5.—Shafts should be fixed at proper distances on first laying out the workings, 5.—Explosion at Oldbury, October,

COAL OIL.

1850, 6.—Wire-gauze lamp; its use and abuse, 6.—Opinion of the Committee of the House of Commons in 1835, and of the Edinburgh Reviewers of 1849, on ditto, 7.—Produce of the mines, 7.—Carelessness and foolhardiness of workmen, 10.—Occurrence of repeated explosions in the same pit, 11.—Practice of blasting open to objections, 11.—Goaf, or waste, source and seat of explosions, 11.—Means of prevention of danger from ditto, 12.—Description of goaf basin and goaf hollow, 14.—Supposed ventilation of the goaf by the general air current, 16.—Filling up of the waste by falls from the roof, 16.—Conclusions arrived at by scientific reporters, 17.—Appendix, Tabular view of some recorded explosions in coal mines, 19.—Ditto, Table containing principally engineering particulars, 21. Discussion.—Glynn, J., 22.

Gas, introduction of, for lighting, (Hawksley, T.), xvii. 13.

Water-pressure engines, employment of, in, (Richardson, J.), ix. 382, 385.

Vide also COAL, and MINES.

Coal oil, Renwick's patent for saturating timber with, ii. (1842) 68.

Coal tar pitch, the most effective substitute for sheathing for vessels, ii. (1842) 67, 68.—Prevents the attacks of the 'teredo-navalis,' 67.—Superior to vegetable pitch, 67.—Contains sulphocyanic acid, 68.—Found to decay timber unless it is deprived of ammonia, 68.—Extensively used for ships in the Mediterranean, 68.—Used to form an impermeable covering on arched roofs, 142, 148.—Mixed with engine ashes for ditto, 145. *Vide also* TIMBER, Preservation of.

Coal trade of Great Britain, and particularly of London, xiv. 342; xvii. 359, 400.—Gradual development of the sea-borne tonnage up to 1850, and since that year the increase in the amount brought up by railway, 408. *Vide also* COLLIERIES, Steam and sailing.

COASTS.

Action of the sea upon, (Gordon, A.), ii.

COASTS.

(1842) 127; (Palmer, H. R.), 129; (Paeley, Sir C. W.), 130; (Farey, J.), viii. 204.

Dover, accumulation of shingle, and the deposition of silt at, (Walker, J.), vii. 400.

Elevation of the sea and depression of the land and *vice versa*, (Conrad, F. W.), ii. (1842) 173; (Harrison, J. T.), vii. 339.

English. "Observations on the causes that are in constant operation tending to alter the outline of the English coast, to affect the entrances of the rivers and harbours, and to form shoals and deeps in the bed of the sea." By J. T. Harrison, vii. 327.—Works consulted, 327.—Causes in constant operation, with more or less intensity, 328.—Origin and progress of rivers, 328.—Earthy and other matters brought down by fresh-water streams and rivers, 329.—Nature and action of waves, 329.—Distinctive characters of the wave of translation, and of the undulating wave, 330.—Mr. Scott Russell's opinion as to the tidal wave being the great wave of translation, 331.—Effect of the tidal waters running alternately into and out of rivers and estuaries, 332.—Ditto of the tidal waves in the open sea, 332.—Extract from Mr. Stevenson's Paper on the bed of the German ocean, 332.—Course of a tidal wave in the English Channel, 333.—Consequences of the ebb current being stronger than the flood, 333.—Peculiarities in the effects along the coasts, 334.—The Races of Alderney and Portland, 334.—The effects of the tide 'round the Isle of Wight, 335.—Times of high water on the coast, at the Isle of Wight, on the opposite French coast, and in the North Sea, 336.—Was England ever connected with the Continent at the Straits of Dover? 338.—General action of the tidal wave in the Channel, 339.—Are the Romney Marshes a consequence of the breaking through of the sea at the Straits of Dover? 339.—Effects observable from the action of

COASTS.

wind-waves on the beach, 340.—Best direction for the construction of groynes for the collection of shingle, 344.—The Chesil Beach and Dungeness, 344.—Effect of the tidal wave in aiding encroachments upon the coast, 344.—Influence exerted by streams, rivulets, rivers, and estuaries, running inland along the coast, 345.—Result of continued encroachments of the sea upon the land in the Great Western Bay, 346.—Geology of the neighbourhood, 347.—Manner in which the changes have been brought about in the Great Western Bay, 348.—Process of encroachment in this bay still going on, 350.—Examination of the present state of the Exe and the Teign, 351.—Various actions to which the material of the coast is subjected, 355.—Appendix, Table showing the times of high water on full and change, and the rises of spring and neap tides, in feet, at different places, 358.

Discussion.—Bateman, J. F., 361.—Beardmore, N., 361.—Green, J., 360.—Harrison, J. T., 361, 362.—Rennie, G., 361.—Russell, J. S., 363.

English, South. "On the alluvial formations and the local changes of the south coast of England." By J. B. Redman, xi. 162.—First section, from the river Thames to Beachy Head, 162.—Course of passage of shingle, 162.—Groynes along the south coast, 162.—Chalk promontory of the Isle of Thanet, 163.—Dover harbour, its progressive construction, 164.—Effect of artificial works of Folkestone harbour, 167.—Circular stone tower at Sandgate, 167.—Shorncliff Battery, 167.—Romney and Lympne, 168.—'Falls' of beach between New Romney and Lydd, 170.—Increase of Dungeness Point, 173.—Original cause of formation of ditto, 176.—Rye harbour, 177.—Proposals for constructing harbours at Hastings, 177.—Breaks in line of beach at Hastings and St. Leonards, 178.—Langley Point, 179.—Uninterrupted belt of shingle from Dungeness to

COASTS.

Langley Point, 183.—Second section, from Beachy Head to Portland, 184.—River Cuckmere, 184.—Seaford Head, 185.—Newhaven harbour, 185.—Groynes between the harbour and Seaford-road, 186.—Mode of protecting cliff in front of Brighton, 186.—Shoreham harbour, 187.—Groynes along the frontage of Worthing, 188.—River Arun, 188.—Pagham harbour, 189.—Chichester harbour, 190.—Portsmouth harbour, 190.—Calshot point, 191.—Deposit of pebbles between Beaulieu, Lymington, and Hurst, 191.—Hurst Point, 191.—Christchurch harbour, 194.—Report of Capt. Washington on the memorial of the mayor and corporation of the borough of Harwich, 195.—Poole and Wareham harbours, 197.—Swanage bay, 198.—Dorset coast, 198.—Lulworth cove, 200.—Weymouth bay, 200.—Chesil bank, 201.

Discussion.—Adams, W. B., 215.—Belcher, Admiral Sir E., 208, 213.—Oodeo, J., 216, 218, 220.—Oubitt, Sir W., 205.—Deane, —, 217, 219.—Hawshaw, J., 219.—Homersham, S. C., 219.—Howlett, S. B., 213.—Lyell, Sir C., 205.—Newton, W., 205.—O'Brien, Capt., 208, 219.—Price, J., 216.—Redman, J. B., 205, 206, 222.—Rendel, J. M., 222.—Rennie, G., 206, 220.—Russell, J. S., 212, 221.—Smith, R., 212.—Webster, T., 220.—Wilson, J., 213.—Wright, J., 214.

Frith of Forth. "Description of the formation of the townlands of Musselburgh, on the Frith of Forth." By J. Hay, iii. 127.

Lowestoft (Bidder, G. P.) viii. 203.

Norway and the western coasts of Ireland and Scotland (Murray, J.), vii. 411.

Preservation of, by groynes, &c. (Murray, J.), vi. 148; (Edwards, G.), 144.

South Devon (Harrison, J. T.), viii. 201, 205; (Moorsom, Capt. W. S.), 201; (Bidder, G. P.), 203.

Vide also CANALS, Great North Holland; CHESIL BANK; HARBOURS; HARBOURS OF REFUGE; and SEA DEFENCES.

COCHRANE.

COCHRANE, A. B. [Election, x. 57.]

COCHRANE, C.

Streets. "On the present state of the streets of the Metropolis, and the importance of their amelioration," ii. (1843) 202.

COCHRANE, J. [Election, xv. 47.]

COCHRANE, Major.

Sleeper, cast-iron (Adams, W. B.), xi. 255.

COCKAYNE, O. [Election, xiv. 374.]

CODDINGTON, Captain J. W., R.E. [Election, iv. 63; Member of Council, vi. 46; memoir, xiv. 165.]

Rivers, improvement of, xii. 13.

Code system in long lengths of telegraphs xvii. 315.

Coffee, application of the hydrostatic percolator to making, xiii. 419.

COFFER-DAMS.

Caledonian canal. Sea-locks at Fort William and Inverness, by Telford (Rennie, Sir J.), v. 42.

Clay and tow waste in bags, used for, (Gibbs, —), i. (1837) 35.

Construction of, (Walker, J.), viii. 303; (Radford, W.), 303; (Abernethy, J.), xvii. 553.

Great Grimsby. "Description of the coffer-dam at Great Grimsby." By C. Neate, ix. 1.—Situation of Grimsby, 1.—Entrances to the old and new docks at Grimsby, 2.—Description of the dam, 3.—Test of its stability, 5.—Borings over the site of the intended works, 5.—Embankments for completing the enclosure, and connecting the coffer-dam with the shore, 6.—Flood-gates at east end, and manner of efflux of water through them, 7.—Supply of water from the chalk rock at Grimsby, 8.—Notice of the intended permanent works for the Port of Grimsby, 8.

Discussion.—Brunel, I. K., 18.—Buckland, Dr., 14, 19, 20, 21.—Clark, T., 14.—Cubitt, Sir W., 9.—Errington, J. E., 12.—Giles, A., 20.—Murray, J., 11.—O'Brien, Capt., 13.—Rendel, J. M., 9, 12, 13, 16, 20.—Russell, J. S., 11.

Houses of Parliament. "A description of the coffer-dam at the site for the New Houses of Parliament." By G. S.

COINING-MACHINERY.

Dalrymple, i. (1840) 18.—Details of the river-wall, 19.—Cost of the foregoing, 19.

River Ribble. "Description of a coffer-dam used in excavating rock from the navigable channel of the river Ribble." By D. Stevenson, i. (1841) 81.—Notice of the proposed works, 82.—The construction of the dam described, 82.

Royal Border bridge, over the river Tweed, on the York, Newcastle, and Berwick railway (Bruce, G. B.), x. 221. Sheerness, by the late Mr. Rennie (Rennie, Sir J.), v. 42.

Southampton, (Giles, A.), ix. 20; xvii. 540. *Vide also Docks, Southampton.*

Sunderland docks, (Murray, J.), xv. 422. *Vide also Docks, Sunderland.*

Thames, at Richmond. "Description of the coffer-dams used in laying the lines of water-pipes between Twickenham and Richmond crossing the river Thames." By G. J. Munday, xiv. 32.—Transfer of sources from whence water is drawn, to points higher up river, 32.—Peculiarities of site, 33.—Requisitions stipulated for by Thames Navigation Committee, 33.—Sizes of dams, and details of different parts, 33.—Method of laying the pipes, 35.—Materials employed, and cost of works, 36.

Discussion.—Beardmore, N., 41.—Hack, W. B., 37.—Hawkshaw, J., 39.—Munday, G. J., 37.—Rawlinson, R., 40.—Rennie, Sir J., 38, 40.—Simpson, J., 39, 41.—Stephenson, R., 37, 41.

Victoria bridge, river Wear, (Bremner, D.), ii. (1843) 98.

—, across the St. Lawrence, near Montreal, (Stephenson, R.), xiv. 38.

Westminster-bridge. "A description of the coffer-dam round the 13 and 14 feet piers of Westminster-bridge." By Lieut. F. Pollock, M.E., i. (1839) 66.

Discussion.—Walker, J., 67.

COFFEY, A. [Election, iii. 66.]

COFFEY, Q. [Resignation, xi. 98.]

Coining-machinery, v. 51.

COINS.

Coins, measures, and weights, on the French system of, and its adaptation to general use (Yates, J.), xiii. 272. *Vide* DECIMAL COINAGE, ETC.

Coke, i. (1839) 40, 42.—Straw coke, 67 —Consumed on railways, ii. (1843) 102, 105.—Increased strength of cast-iron produced by the use of improved coke, xii. 352.—Manufactured, xiii. 414.

Vide also ANTHRACITE, COAL, FUEL, LOCOMOTIVE BOILERS, LOCOMOTIVE ENGINES, STEAM BOILERS, and STEAM ENGINES.

Coke ovens, i. (1839) 36, 41, *et seq.* *Vide* also COAL, and FUEL.

COLBURN, Z.

Locomotive engines. Goods-engines used on the Baltimore and Ohio railway, and as to the adhesion of the driving-wheels, xviii. 63.—Coal burning locomotives in the United States, with descriptions of Phleger's, Dimpfel's, and Boardman's boilers, and of the plans used on the Boston and Providence and Iowa Central railroads, xix. 572.

Railway trains, resistances to; trials on the Cleveland and Pittsburgh and New York and Erie railways, xviii. 63.

COLBY, General T. F. [Memoir, xii. 132.]

COLES, Captain C. P., R.N.

Defences, national. Extract from his evidence, taken before the Commissioners appointed to consider the defences of the United Kingdom, xx. 585.—Reprint of his pamphlet on "Our National Defences," 542.—Ditto "Spithead Forts."—Reply to the Royal Commissioners' second report on our National Defences," 572.

Collieries, ventilation of, theoretically and practically considered, (Struvé, W. P.), x. 22. *Vide* also MINES.

COLLIERS.

Introduction of screw colliers for the supply of coals to London, (Murray, J.), xvii. 406.

Steam and sailing. "On the comparative cost of transit by steam and sailing colliers, and on the different modes of ballasting." By E. E. Allen, xiv. 318.

COLT.

—Construction of screw-colliers, 318. —Relative cost of transit by screw and sailing colliers, 318.—Sand ballast, 328.—Dr. D. B. White's bag-water ballast, 329.—Bottom-water ballast, 333.—Hold-water ballast, 334.—Tank-water ballast, 335.—Employment of screw-colliers for distant coaling-stations, 336.—Coal trade of Great Britain, and particularly of London, 342.—Areas of coal formation in different parts of the world, and production in 1853, 343.—Area of coal-fields of the United Kingdom, 344.—Coals brought into London in 1853, 345.—Charges made on colliers entering Port of London, 346.

Discussion.—Allen, E. E., 349, 353, 363, 369, 373.—Beardmore, N., 356.—Bidder, G. P., 367.—Crampton, T. R., 370.—Croome, J., 350, 355, 366, 369.—Fletcher, L. E., 349, 353.—Fowler, J., 358.—Hawkshaw, J., 359.—Henderson, Capt., 352.—Humphrys, E., 369.—Jackson, R. W., 355, 358.—Palmer, C. M., 365.—Russell, J. S., 360.—Spencer, J. F., 352.—Stephenson, R., 349, 371.—Wimshurst, H., 370.

Water ballast for, Dr. White's system of, (Simpson, J.), xiii. 196.

COLLINGS, A. [Election, iii. 173.]

COLLINGS, C. [Auditor, i. (1841) 52; memoir, ii. (1843) 18.]

COLLINGWOOD, Captain C. T., M.A. [Election, xvi. 226.]

COLLINS, J. [Election, xii. 352.]

COLLINS, W. W. [Election, v. 340.]

COLLINSON, Lieutenant-Colonel T. B., R.E. [Election, xx. 586.]

Colne, River, water level from the, to London, ii. (1843) 156.

Cologne Cathedral, crane used in erecting, iii. 208.

Colonnade, or viaduct, constructed at Salford, (Hawkshaw, J.), xi. 241.

COLQUHOUN, Lieutenant-Colonel, R.A. [Election, ii. (1843) 134; Member of Council, v. 142; memoir, xiii. 149.]

COLT, Colonel S. [Election, xi. 477; Telford medal, xii. 115.]

Fire-arms. "On the application of ma-

COLTHURST.

chinery to the manufacture of rotating chambered-breech fire-arms, and the peculiarities of those arms," xi. 30.—Remarks, 51.—Combination of bowie-knife and repeating-pistol, made in 1836, 51.—Making breech end of the barrel conical, 54.—Details of manufacture of his repeating fire-arms by machinery, 59.—Statistics of work in his factory at Hartford, U.S., 60.—Weights of different weapons, 61.—Tools used in manufacture of his arms, 62.

COLTHURST, J. [Election, i. (1841) 163; Walker premium, ii. (1842) 9.]

Beams. "Experiments for determining the position of the neutral axis of rectangular beams of cast and wrought iron and wood, and also for ascertaining the relative amount of compression and extension at their upper and under surfaces, when subjected to transverse strain," i. (1841) 118.

Bridges. Strength of the sides of the main girders of the Torksey tubular bridge, ix. 272.

Metals. "An account of some experiments to determine the force necessary to punch holes through plates of wrought iron and copper," i. (1841) 60.

Railway cuttings and embankments, and embankment at Hanwell, iii. 161, 168.

Scaffolding, iii. 209.

— "Description of the method employed for repairing a chimney 120 feet high, at the cotton mill of Messrs. Couper, Glasgow," 223.

Timber. Amount of saturation of timber under the process of Kyanizing, ii. (1842) 84.

Column, Malcolm, Eskdale, iii. 211.

—, Nelson, scaffolding used in erecting, (Grissell, T.), iii. 203.

—, York (Carlton Terrace), iii. 209.

COLVIN, Colonel.

Foundations. His modification of the Indian well system referred to, (Goodwyn, Colonel), ii. (1842) 64; (Abbott, Colonel Sir F.), xvi. 457.

COMBINED VAPOUR ENGINE.

COMBE, J. [Election, ii. (1842) 138; Walker premium, ii. (1843) 7; resignation xiii. 134.]

Flax mill. "Description of a flax mill recently erected by Messrs. Marshall and Co., at Leeds," ii. (1842) 142.

COMBINED VAPOUR ENGINE.

"On the performances of the screw steam-ship 'Sahel,' fitted with Du Trembley's combined vapour engine, and of the sister ship 'Oasis,' fitted with steam engines worked expansively, and provided with partial surface condensation." By J. W. Jameson, xviii. 233.—Description of Du Trembley's combined-vapour engine, 233.—Ditto of the engines of the 'Sahel,' 233.—Construction of the vapourizer and of the condenser, 234.—Experiments on board the ship 'Du Trembley,' 237.—Application of the combined-vapour system in the ships 'France' and 'Brésil,' belonging to the 'Compagnie de Navigation Mixte,' 237.—Reports of M. Meissonnier and of M. Gouin on the performances of ditto, so satisfactory as to determine the extension of the system to seven new ships, 237.—Burning of the ship 'France,' in the port of Bahia, and failure of the Brazilian line of steamers, led to partial suppression of the system, 238.—Unsuccessful trials of ether engines in the ships 'Jacquard' and 'François Arago,' belonging to the 'Compagnie Franco-Américaine,' which were then arranged to work by steam alone, the tubular apparatus being made use of for surface condensers, 238.—Report of experiments conducted by M. Moreau to determine the relative economy of the two systems, 238.—Results of twelve voyages each of the ships 'Sahel' and 'Oasis,' particularly as regards the consumption of coal, 239.—Consumption of fuel per I. H. P. in marine engines, 241.—Economy in favour of the combined-vapour ship 'Sahel,' 243.—Statement of the performances of the 'Sahel,' 245.—Accident on board the ship

COMBUSTION.

- 'France,' in the port of Messina, as described by M. Meissonnier, 245.—Ditto 'Brésil,' in the dry dock at Marseilles, 246.—Burning of the ship 'France,' in the port of Bahia, 246.—Difficulty of condensing the ether, 247.—Occasional leakage of the vapourizer, 248.—Great economy in the consumption of fuel due to the combined system, 248.—Possible discovery of a cheap, non-inflammable liquid, free from the objections to the use of ether, 248.—Appendix I. Description of the engines of the ship 'Sahel,' 251.—Appendix II. Table of Results, 252.
- Discussion.—Bramwell, F. J., 260.—Cowper, E. A., 267, 283.—Dinnen, J., 275.—Du Trembley, M., 290.—Fletcher, L. E., 281.—Greaves, C., 268, 287.—Grove, W. R., 259.—Hensman, H., 260.—Homersham, S. C., 273.—Humphrys, E., 271.—Jameson, J. W., 294.—Joule, J. P., 253.—Locke, J., 294.—Murray, A., 271.—Rankine, W. J. M., 274.—Rennie, G., 253.—Russell, J. S., 279.—Siemens, C. W., 256, 290.—Spencer, J. F., 292.—Stephenson, R., 272, 274.
- Combustion of coal. *Vide* COAL, FUEL, &c.
- of oil in lighthouses, ii. (1843) 206.
- Products of the combustion of oil and gas, ii. (1843) 184, 185.—Injurious to the books, furniture, &c., at the Athenæum Club, 184.
- , slow, of the gluten and starch in brewers' wort, ii. (1843) 170.
- , spontaneous, caused by a substance formed by Sir H. Davy's protector, ii. (1842) 67.—Similar result in experiments on cast-iron, by Mr. F. Daniel, 67.
- Compass, Capt. Kater's prismatic azimuth, xi. 24.
- CONCRETE, A. [Memoir, xv. 96.]
- CONCRETE AND RUBBLE BÉTON.
- Béton, used in France for the construction of sea defences (Jones, General Sir H. D.), ii. (1842) 126.—Ditto at Algiers, cast in caissons (Gordon, A.), 127.—Ditto in ancient works (Rennie, Sir J.), v. 34.—Concrete, formation of, (Hawkins, J. J.), vii. 70.

CONCRETE.

- "On the employment of rubble béton or concrete, in works of engineering and architecture." By G. Rennie, xvi. 423.—Coeval with the earliest periods of antiquity, 423.—Art of building in rubble derived from Italy, 423.—Quotation from Vitruvius, as to harbours and other buildings in water, 424.—Rubble used in all the public buildings in Rome, and throughout the Roman Empire, 425.—Early use of concrete and béton, 426.—Vicat's researches as to the theory of the action of limes with siliceous materials, 427.—Treussart's investigations on mortars and cements, 427.—Messrs. Gariel's establishment for the manufacture of Vassy cement, 428.—Works executed in Vassy cement in Paris, 428.—Details and cost of the Pont de l'Alma, 428.—Mode of slackening the centres of ditto, 430.—Use of blocks of béton for the outer slopes of breakwaters, 431.—Application of rubble and cement to ecclesiastical and feudal buildings in England, 432.—Smeaton's experiments on water cements, 432.—Sample on building in water, 432.—Higgins on calcareous cements, 433.—Parker's patent for cements, 433.—Pasley on limes, cements, &c., 433.—Introduction of concrete in the foundation of the Millbank Penitentiary, 433.
- Discussion.—Burnell, G. R., 437, 444.—Giles, A., 437.—Greaves, C., 440, 443.—Hood, R. J., 443.—Manby, C., 445.—Pasley, Lieut.-Gen. Sir C. W., 443.—Penrose, F. C., 437.—Rawlinson, R., 436.—Rennie, G., 436.—Simpson, J., 438.—Stephenson, R., 447.—Vignoles, C., 438.—Walker, J., 439, 444.—White, G. F., 439, 442.
- Vide* also CEMENTS; and STONE, ARTIFICIAL.
- CONCRETE, C. E.
- Bridges, suspension, xvi. 458.
- and LUKIN, A. S.
- Bridges, suspension. "On the disturbances of suspension bridges, and the modes of counteracting them," xvi. 458.

CONDER.

CONDER, F. R. [Election, xv. 47; Council premium, xvii. 80.]

Permanent way. "On the laying of the permanent way of the Bordeaux and Bayonne railway, through the Grandes Landes," xvi. 371.

Conduits, pipes, and orifices, flow of water through, (Leslie, J.), xiv. 273.

Cones sunk at Cherbourg, ii. (1842) 124.

CONGLETON, Lord. [Memoir, ii. (1843) 11.]

Connecting rods, comparative advantages of long and short, and long and short stroke engines (Seaward, J.), i. (1841) 53.

CONRAD, Chevalier F. W. [Election, ii. (1843), 105; Telford medal, ii. (1843) 6; Walker premium, iv. 4.]

Bridges. "Description of the method adopted in preparing the foundation, and in building the bridge over the Poldevaart, on the line of the Amsterdam and Rotterdam railway," vi. 149.

Canals. "The history of the canal of Katwyk (Holland), with a description of the principal works," ii. (1842) 172.

Railways. "Account of the railway from Amsterdam to Rotterdam, and of the principal works upon it," (Manby, C.), iii. 173.

Consumption of fuel in steam-vessels, xiii. 53.

CONTÉ, —.

Instruments for measuring pressures and temperatures (Bourdon, E.), xi. 15.

CONYBEARE, H. [Election, xvi. 46.]

Artillery, construction of, xix. 380.—Disruptive force of the powder, and the inertia and friction of the projectile, 381.—Use of cast-iron for the construction of ordnance, especially as to experiments made by the officers of the U. S. Ordnance Department, with iron guns cast hollow on Lieutenant Rodman's plan, and with Captain Dahlgren's gun, 382, 384.—Experiments recorded in the United States reports, on the extreme proof of cast-iron ordnance under hydrostatic pressure, and of casting guns hollow on chilled cores, 384.

CONYBEARE.

—Cast-iron gun of the future, and the form of rifling it, 388.—Guns used for naval armament, and coast defences, 389.

—Common standard of ratios for recording experiments on various descriptions of rifled arms, and for registering the elements of each, 389.—Table giving the elements of twelve of the most approved rifled arms, 391.—Principles of effect in rifled projectiles, and the classes of projectiles in use, 393.—Effect of twist in rifles, 400.—Lieutenant Rodman's system of casting guns hollow on a chilled core, xx. 469.—Range of rifle shell guns, 469.—The two classes of projectiles for rifles and rifled ordnance, 470.—Means of closing the breech of a breech-loading gun, 470.

Defences, national, xx. 458.—Screw liners forming the present line of battle of European navies, and their defects, 458.—Comparison between the 'Gloire' and the 'Warrior,' 460.—Primary essentials of an iron-plated liner, 462.—The French have always excelled in the art of designing vessels of war, 463.—Naval forces of Great Britain and of France, 464.—Impolicy of England taking the initiative in the introduction of steam liners, of iron-plated men-of-war, and of rifled ordnance, 465.—Necessity of fortifying the arsenals, as bases of operation for the steam fleet, 466.—Basins of Cherbourg, Toulon, and Brest, compared with those of Portsmouth and Keyham, 466.—Coast and harbour fortifications should be defensible against iron-plated vessels of war, 468.

Public works in India. Ganges canal and the Grand Trunk road, and employment of military engineers on civil engineering duties, xvii. 517.—Funds appropriated to public work extension incommensurate with the requirements of the country, 518.—Evils arising from the defective system and inappropriate agencies, 518.—Cost of superintending, 519.—Abstract of the Annual Reports of the Bombay road and Tank Depart-

COODE.

ment, 520.—Evils of the delays in the execution of public works, 520.—Necessity for the employment of civil engineers on the public works of India, 521.—Plan for reorganizing the Public Works Department, 522.

Railways, introduction of, into Western India, xvii. 514.—Causes of the delays in the progress of Indian railways, 510.

Water supply. "Description of the works, recently executed, for the water supply of Bombay, in the East Indies," xvii. 555.—Remarks, 569.—Importance of works for impounding water, for the purposes of irrigation, 569.—Cost of impounding water in Rajpootana, 569.—Necessity of ascertaining the average rainfall, over the entire area of the gathering grounds, 570.—Proportion of the ascertained average rainfall over the gathering grounds, available for storage, 570.—Construction of dams for impounding water, 571.—Appliances for drawing off the water of a reservoir at different levels, 572.—Mechanical appliances connected with the water-supply of towns, 573.

—, particularly the construction of dams for impounding the water, and the great amount of waste in the water-supply to large towns, xviii. 388.

COODZ, J. [Election, viii. 164; Telford medal, xiii. 126.]

Breakwaters and piers. Cost of Portland breakwater, xviii. 102, 110.—Details of construction, 128.—Plan of the pier at Holyhead, 129.

Chesil bank, &c., xi. 217.—Shambles shoal off Weymouth, 217, 218.—Position of different sized pebbles in Chesil bank, 220.

—"Description of the Chesil bank, with remarks upon its origin, the causes which have contributed to its formation, and upon the movement of shingle generally," xii. 520.—Remarks, 547.—Line of demarcation between the shingle and the sand, 547.—Tide stream, up to Wyke from the Start

COOPER.

Point, and tide in the Race of Portland, 547.—Formation of Chesil bank, 554.—Origin of, 555.

Labour, convict, at Portland, as to the profit, or loss, by the employment of, xviii. 111, 128.

Pebbles, position of different sized, on a beach, xii. 554.

Railways, 'zig-zag' system of construction, for crossing high mountains, first proposed for traversing the Guadarama Pass, xviii. 69.

COOKE, A. T. [Election, xv. 348.]

COOKE, J. S. [Election, xx. 292.]

COOPER, James.

Breakwaters. Construction of the breakwater at the Port of Blyth, and of the Admiralty Pier at Dover, xviii. 101.—Breakwater at Alderney, xix. 668.

Canal, works on the Netherton tunnel branch of the Birmingham, xix. 278.

Dock gates, wood a preferable material to iron for, xviii. 481.

Drainage of land. Works for the improvement of that part of the Bedford Level called the Middle Level, xix. 101.—General legislative enactment on drainage, 102.

Piers, at Alderney, at St. Catherine's, Jersey, and at Dover, xviii. 101, 130.—Cost of the Admiralty Pier at Dover, 141.

River Orwell, xx. 16.

COOPER, John.

Timber, action of the worm on Kyanized, i. (1840) 69.—Process of Kyanizing, i. (1841) 91.

COOPER, J. T. [Election, i. (1840) 75.]

Gas. Experiments as to the process of endosmose and exosmose, iii. 307.

India rubber, unchanged character of vulcanized, from simple immersion in water, xiii. 434.—Process of vulcanizing, 434.

Photography as applicable to engineering, i. (1840) 59.

Pipes, leakage through metal, iv. 249.

Steam boilers, means of preventing the incrustation of, v. 202.

Timber, decay of, by dry rot, xii. 230.—Examination of specimens of timber

COOPER.

variously prepared for preserving it from decay, 231.

COOPER, T. E.

Fuel, resin, i. (1839) 35.

London, atmosphere of, sal-ammoniac and muriate of ammonia always found in, i. (1839) 34.

Copper and tin ores, methods generally adopted in Cornwall in dressing, (Henderson, J.), xvii. 195.

Copper mines, Wheels Betsey, and Friendship, water-wheels and pumps at, ii. (1843) 97, 98, 99.

— pipes destroyed by the bilge-water of vessels, ii. (1842) 154.

— sheathing, for vessels, historical account of, (Wilkinson, J. J.), ii. (1842) 65.

Coradino tank, Malta, ii. (1843), 140.—Forms part of the works for supplying Malta with water, 140.—Described as the largest covered tank in Europe, 140.

CORLETT, C. H. [Election, x. 244.]

CORLETT, H. L. [Election, xix. 461.]

Cornish engines (Wicksteed, T.), i. (1838) 2. *Vide also* STEAM ENGINES.

Cornwall stone, or decomposed felspar, the same as china clay or 'Kaolin,' ii. (1843) 154.

Corps of civil auxiliaries for the Crimea, xiv. 98.

Corrosion of different substances, i. (1839) 33.

— of metals. *Vide* METALS, Corrosion of.

Corrugated iron used for roofs and bridges, iii. 288, 290.

CORRY, E. [Election, xviii. 296.]

COTTAM, E. [Election, i. (1839) 59.]

Coke ovens, i. (1839) 42.

Materials, strength of, i. (1837) 28.

Metals, corrosion of, i. (1839) 33.

Steam engines, duty and effect of, i. (1840) 17, 22.

Warming and ventilating, i. (1837) 43.

COTTAM, E. [Election, xix. 130.]

COTTAM, G. [Resignation, xvii. 85.]

Air engine, Stirling's, iv. 356.

Beams, proper dimensions and proportions of cast-iron, and columns, iv. 348.

Fire-proof buildings, construction of, and

COWPER.

especially as to the state of iron after fires, viii. 148.

Iron, cast, change of, into plumbago, iii. 86.

Iron, mode of experimenting on the strength of, ii. (1843) 128.

Cotterell's patent climax detector-lock, xiii. 256, 267.

COTTON, C. P. [Election, xx. 586.]

COTTON, W. [Telford medal, ii. (1843) 6.]

Automaton balance, invented by him (Oldham, T.), ii. (1843) 122.—His remarks on ditto, 124.

Huddart, Captain. "A memoir of Captain Huddart," ii. (1842) 56.—Collection of Captain Huddart's MSS. and instruments, ii. (1843) 9.

Machinery. "On Captain Huddart's improvements in rope machinery," i. (1838) 1.

COULTHARD, G.

Bridge, Ouse, model of the, iv. 90.

COULTHARD, H. C. [Election, xx. 106.]

COULTHARD, W. [Election, viii. 310.]

COULTHARD, W. R. [Election, xvi. 226.]

Council, Annual Reports of. *Vide* ANNUAL REPORTS OF COUNCIL.

Counter, for steam engines iii. 70.

—, engine, on an improved principle. (Richmond, J.), vii. 71.

Counterforts and revetments. *Vide* RAILWAY CUTTINGS.

Couplet's experiments on the discharge of water through a pipe 18 inches in diameter, xiii. 117.

Coupling's for mill-spindles, ii. (1842) 61.

COUET, S. C. [Election, xii. 206.]

COVENT GARDEN THEATRE.

Alterations at, (Albano, B.), vi. 222.

"Decayed bond timbers in the walls of Covent Garden Theatre." By B. Albano, vi. 255.

COWEN, G. [Election, xiii. 421; memoir, xvii. 98.]

COWEN, R. [Election, iii. 66.]

COWLEY, J. [Election, ii. (1842) 72.]

Cowlin brook bridge built with hollow piers ii. (1842) 176, 177.

COWPER, C. [Election, ix. 308.]

Arches. Pressures on the piers at St. Paul's, and other remarkable structures,

COWPER.

- x. 241.—On the voussoirs of the Pont-y-tŷ-Prydd, over the Taff, 241.
- Foundations. Weight on the bases of some high brick chimneys, x. 242.
- Motive power. Application of electricity to the production of motive power, and description of three different machines for that purpose, xvi. 405.—Mr. Joule's researches on the economical production of mechanical effect from chemical forces, 410.
- Steam engines. Watt's standard of horse power, and as to the nominal horse power of steam engines, x. 310.—Allowance for the friction of the engine, 315.
- COWPER, E. A. [Election, xi. 148.]
- Artillery. Swedish percussion shell, xix. 373.—Principal distinctions between different guns, 374.—Wire-bound gun, 375.—Attainment of long ranges, 376.
- Beams, forces in action in the case of rectangular, xvi. 79.
- Bridges, wrought-iron, xiv. 480, 489.
- Coal, shipment of, at the Tyne docks, angle at which coal will slide on smooth iron plates without rolling, and plans for lowering coal into a ship so as to prevent breakage, xviii. 508.
- Fuel, combustion of, with regard to the prevention of smoke, and relative values of coal and coke, xix. 580.
- Iron and steel, Bessemer process for the production of malleable, xviii. 532.
- Lights, floating. Proposed circular wrought-iron light-tower, and manner of mooring, xv. 11.
- Locomotive engines, admission of air, through hollow stays, into the fire-boxes of, xix. 581.
- Marine engines, objectionable practice of making, without steam jackets, particularly when working expansively, xviii. 267, 283.
- Railway signals, use of maroons for, i. (1841) 116.
- Roofs. Iron roof over the joint railway station, New-street, Birmingham, xiv. 264.—Roof of building-slip No. 4, at Woolwich dockyard, 264.—Roof of Tythebarn-street station, Liverpool,

CRAB.

- 264.—Calculating strength and weight of roofs, 270.
- Steam, and other gases, in expanding, give out heat, and lose power, xii. 598.—Extent of the loss which occurred with different amounts of expansion when no steam jacket was used, and as to the advantage of super-heating steam, xix. 483.
- Steam engines. Indicator diagram taken from an engine without a steam jacket, xii. 598.—Feed-water heaters, xix. 580.
- Valves. New arrangement of the ring valve, xii. 456.
- COWPER, Professor E. [Telford medal, x. 66.]
- Brickmaking. Prosser's method of clay-moulding, ii. (1843) 149.
- Bridges, suspension, causes of injury to, i. (1841) 77, 79.
- Building materials. 'Pisa-work,' ii. (1843) 152.
- Machines. "On printing machines, especially those used for printing 'The Times' newspaper," ix. 409.
- Permanent way. "Description of a running gauge for ascertaining the parallelism of a railway," i. (1840) 30.
- Railway, atmospheric, iii. 272.
- Railway cuttings, iii. 145.—Slips of, 145.
- Screw propellers, iii. 81.
- Surveying instruments. "An azimuth cap as an addition to the common level," i. (1840) 31.
- Wheels. "On a method of setting out involute teeth of wheels, so that any two wheels of the same, or of different diameters, will work truly together, whether the teeth bottom, or only just touch each other," i. (1841) 60.
- COWPER, W.
- Indicator, illustration of the action of Moseley's constant, ii. (1842) 107.
- Timber, kyanizing, ii. (1842) 85.
- Cox, H.
- Rotation of the Earth. "On the demonstration, by means of two pendulums, of the rotation of the Earth," x. 320.
- Coxon, B. P. [Election, xx. 292.]
- Crab, or winch, small, xviii. 231.

CRAMPTON.

Cramp-gauge used for laying rails of South Eastern railway, ii. (1842) 76.

CRAMPTON, T. B. [Election, v. 248; Telford premium, ix. 95; Member of Council, xii. 112.]

Colliers, steam and sailing. Bottom-water ballast, xiv. 371.

Fuel. Comparative evaporative efficiency of coal and coke, xvi. 30.

Gutta percha, non-durability of, when exposed to air and light, xii. 457.

Locomotive engines. "On the construction of locomotive engines, especially with respect to those modifications which enable additional power to be gained, without materially increasing the weight, or unduly elevating the centre of gravity," viii. 233.—Remarks, 240.—Coupled goods-engine on the Edinburgh and Northern railway, and distribution of the weights on the wheels of coupled engines, 240.—Steadiness in locomotive engines, 245, 249, 252.—Objections to engines with the driving-wheels behind the fire-box, 247, 248, 252, 253.—Comparative advantages of inducing steadiness in locomotive engines, by an extension of base, or by a low centre of gravity, 257.—Comparative advantages of large and small wheels for locomotives, 259, 260.

—, depth of fuel used in, xii. 426.

—Causes of the fracture of the driving-axles of, xiii. 469.—Results of the use of coal-burning locomotive engines on the Great Northern of France railway, xvi. 30.—Form of engine for burning coal in locomotives, 31.—Importance of balancing the working parts, 36.—Conclusions to which he had arrived respecting the requirements of, 37.—Weights on the wheels, 37.—Cost of repairs of engines on his system for eight years on the Great Northern of France railway, 38.

Locomotive boilers, rapid combustion, the most economical in, xii. 414.—Relations between the area of the heating surface and the grate area,

CRANE.

414.—Experiments to determine the best form of locomotive boilers, 424.

Marine engines, employment of high-pressure steam working expansively in, viii. 308.—Makers of marine engines should study the railway practice in reference to the construction of boilers, xii. 415.

Permanent way. Parsons' railway chairs, and system of fastenings, xvi. 295.

Railway inclines. Mode of working Giovi and Semmering inclines, xv. 373.

Railway trains, resistances to, experiments on, v. 428, 430.—Effect of the small distance between the wheels on narrow-gauge lines, vii. 320.

Safety valves, xv. 41.—Application of cup-and-ball principle to, 42.

Steam engines. Indicator, the only guide for manufacturers in determining the amount of horse power, x. 813.

Steam navigation. Registration of area of midship section, form of ship, and indicated horse power of steam vessels, xiv. 396.

Telegraph cables. Submarine cables between Dover and Calais, and Dover and Ostend, xvi. 205.—Part he took in realizing the project for laying a cable from Dover to Calais, 206.—Main features of a design for ditto, as shown in a drawing prepared by Professor Wheatstone, 206.—Failure in the attempt to lay the Mediterranean cable, 224.—Proposed Atlantic cable, 225.—Mode of construction of a submarine telegraph-cable, xvii. 301. Laying of the Dover and Calais telegraph cable, 306.

Water supply. Difference between the maximum and the minimum supply of water in particular districts, xviii. 396.

Crampton's step grate for burning coal in locomotives, xvi. 6.

Crane-barges used for harbour constructions, iii. 119.

CRANE, G. [Election, i. (1838) 5; memoir, vi. 5.]

Iron, anthracite, (Rennie, G.), ii. (1843) 130.

CRANE, P. M. [Election, vii. 75.]

CRANES.

CRANES.

Balance, Malcolm column, Eakdale, (Pasley, Lieut.-Gen. Sir C. W.), iii. 211.—Used in the erection of the Bell Rock light-house in the year 1809, (Stevenson, R.), iv. 340.

Cathedral of Cologne, (Fowler, C.), iii. 208.

Derrick, used at 'Commemoration column', Devonport (Colthurst, J.), iii. 209.—Double derrick, worked by steam at Liverpool (Smith, C. H.), 211.—Moveable, at Granton pier (Howkins, J.), 212; (Brenner, J.), 218; (Walker, J.), 214.—Lossiemouth harbour, 214.

Hydraulic machinery, application to, (Armstrong, Sir W. G.), ix. 386. *Vide* also HYDRAULIC MACHINERY.

Jib, used for building Pulteney Town harbour walls (Brenner, J.), iii. 120.

Moveable beam, used in the erection of the Bell Rock light-house in the year 1808 (Stevenson, R.), iv. 339.

Moveable jib, Glasgow (Gale, W.), iii. 214.—Grangemouth docks (Thomson, J.), 214.—Used in raising the 'stand pipe' of the East London water-works (Wickstead, T.), 214.

— "Remarks on the utility and defects of the moveable jib crane, according to the construction now generally used in Glasgow, with proposed improvements to obviate its defects." By W. Gale, iv. 333.—Description of, as first introduced in the erection of the Bell Rock light-house, 334.—Ditto, as now in use, 334.—Theoretical investigation as to the amount of strain on the jib chain, 335.—Description of proposed alterations in the jib chain and other parts, 335.—Table of experiments, showing the amount of strain on the jib chain according to the present and proposed modes of construction, 337.—Ditto, showing the different calculations entered into to obtain the above, 338.

Discussion.—Cottam, G., 348.—Farey, J., 345.—Rennie, Sir J., 345.—Walker, J., 345.

Revolving. "Description of a thirty-ton

CROKER.

crane erected on the quay of Earl Grey's dock, Dundee harbour." By J. Leslie, i. (1841) 55.

— Revolving crane and scaffold used at the new Houses of Parliament, (Allen, J.) iii. 216.

Victoria bridge, across the river Wear, built in a short time by means of, (Brenner, D.), ii. (1843) 98.

Wellington bridge, Leeds, (Timperley, J.), iii. 105.

Cranston Hill water-works, ii. (1843) 135.

CRAWFORD, R. [Election, xx. 875.]

CRAWSHAY, W. [Election, i. (1838) 24.]

Creep in collieries, iii. 152.

Creosoting timber for preserving it from decay, and from the attacks of the worm, xii. 218, *et seq.* *Vide* also TIMBER.

CRESY, E. [Election, i. (1839) 59.]

CRISP, G.

Air engines. Sir G. Cayley's caloric engine, xii. 325.—Rev. Dr. R. Stirling's air engine of 1816, 325.—Messrs. B. and J. Stirling's engine erected at the Dundee foundry in 1843, 326.—Parkinson and Croxley's air engine, 326.—Ericsson's air engine, 327.—Caloric ship 'Ericsson,' 327.—'Regenerator,' in ditto, 329.—Practical objections to the general arrangement of Ericsson's engine, 331.

CRISPIN, Captain.

Screw propeller, working of a vessel with the, iv. 172.

CRISTOFORI, Signor de.

Railway incline planes, apparatus for ascending, xvii. 16.

CROKER, B. W. [Election, vi. 134.]

Breakwaters, floating, system of, for protecting the entrance to a harbour on the north-west coast of Holland, xv. 23.

Bridges. Suspension bridge over the Danube at Pesth, the dimensions of different parts of the structure, and the method of rolling and testing the bars, viii. 276.—Proportions between the pin, head, and body of bar, 277, 279.

Rivers. Relative advantages of rendering rivers navigable, by means

CROLL.

of long diagonal weirs, with side locks and gates, and by means of side embankments and facing to the original shores, vii. 246.—Plans resorted to for improving the rivers in Hungary, particularly the Danube, which was formerly effected by spurs for deepening the channel, but now by reclaiming the side arms, 247.—Construction of weirs on the Altmühl, 249.—Works for controlling the waters of the river Theiss, 249.—Works executed on the White Körös, 249.

Safety valves, adaptation of volute springs to hydraulic, for the Amsterdam water-works, xv. 42.

Turbine, M. Fourneyron's, at St. Blasieu, in the Black Forest, viii. 61.

CROLL, A. A. [Election, ii. (1843) 134; Telford medal, iv. 3.]

Gas. "On the purification of coal gas, and the application of the products thereby obtained to agricultural and other purposes," iii. 290.

Gas meters. "On the construction and use of gas meters," iv. 211.—Remarks, 218.—Croll's meter, 218.—Amount of gas lost by leakage from the pipes, 221.

CRÖÖME, J.

Water ballast, xiv. 350, 353, 355, 366, 369.

CROSLAND, W. M. [Election, xi. 68.]

CROSLY, E. [Election, xiv. 523.]

CROSLY, W. [Election, ix. 375.]

Gas meters. "On the measurement of gas, and the classes of gas meters in general use," xix. 674.

CROSSE, A. C. [Election, xix. 180.]

Crossing-point, Duncan's, ix. 233.

Crossings, railway, Carr's, xiii. 437.

— and switches, (Burleigh, B.), xiv. 419. *Vide also* PERMANENT WAY.

CROSLY, J. S. [Election, xvii. 296.]

Croydon drainage, and sewage works, and their effect upon the river Wandle, xx. 233, *et seq.*

Crystallization of iron produced by percussion, heat, and magnetism (Hood, C), ii. (1842) 180.—Increased in railway axles by the electricity generated by

CUBITT.

the effluent steam, 181.—Not necessarily dependent upon time for its development, 181.—Produced by the rigidity of the springs, looseness of the brasses, and general vibration of railway carriages, 181.—Exhibited in pump rods and other parts of machinery subjected to concussion, 181. *Vide also* IRON, and RAILWAY AXLES.

Crystal Palace at Sydenham, xiv. 102.

CUBITT, B. [Election, ii. (1843) 134; Member of Council, iv. 62; v. 142; memoir, viii. 10.]

CUBITT, J. [Member of Council, vi. 46; vii. 56; viii. 44; ix. 91; x. 60; xi. 84; xii. 112; xiii. 123; xiv. 97; xvi. 88; xvii. 70; xviii. 164; xix. 132; xx. 108.]

Bridges. "A description of the Newark Dyke bridge on the Great Northern railway," xii. 601.

Canal incline-planes, for boats, on the Chard canal, xiii. 210.

Permanent way. Destruction of railway crossing-points, xiv. 433.

Viaducts, mode of building, Welwyn and Lockwood, x. 800.

CUBITT, L. [Member of Council, ix. 91.]

CUBITT, T. [Election, i. (1839) 49; memoir, xvi. 158.]

Arches. "Experiments on the strength of brick and tile arches," i. (1841) 136.

Girders. "Experiments on the strength of iron girders," i. (1841) 116.

—, cast-iron, his experiments on the strength of, (Dines, T.), xiii. 471.

Roofs, wrought iron, at his works at Thames-bank, description of (Adams, E.), i. (1841), 96.

Smoke, prevention of. Description of his system of passing air over a subsidiary fire, placed under the main furnace, in order to avoid smoke, xiii. 393.

CUBITT, W. [Member of Council, ii. (1842) 51; (1843) 67; iii. 66.]

Brickmaking, ii. (1843) 148.

Roofs. "On a new mode of covering roofs with planking," i. (1840) 68.

Wells. Grenelle artesian well, ii. (1843) 141.—Causes of the approximation of temperature between the water of the

CUBITT.

Grenelle well and that of the Cornish mines at a similar depth, 142.

CUBITT, Sir W. [Vice-President, i. (1837) 15; (1838) 20; (1839) 27; (1840) 36; (1841) 52; ii. (1842) 51; (1843) 67; iii. 66; iv. 62; v. 142; vi. 46; vii. 56; viii. 44; President, ix. 91; x. 60.]

Address, on taking the chair for the first time after his election as President, ix. 133.—Remarks on the tubular bridges across the river Conway, and the Menai Straits, 136.—Ditto on the Commission for inquiring into the application of iron to railway structures, 137.—Ditto on the Portland breakwater, 137.—Ditto on the Bishop Rock light-house, 138.—Ditto on the Skerryvore light-house, 139.—Ditto on the progress of steam navigation, 139.—Ditto on the pontoon at New Holland, 140.—Ditto on the railway system, 141.

— on vacating the chair, xi. 147.

Arches, v. 172.—Line of pressure in, 177.

Beams. Position of the neutral axis, i. (1841) 122.

Blasting. Scaling the face of the cliffs at Dover, x. 295.

Breakwater, Portland, ix. 137.

Bridges. Athlone bridge, viii. 303.—Tubular bridges across the river Conway and the Menai Straits, ix. 136.—Vertical lift bridge over the Grand Surrey canal, on the line of the Thames Junction Branch railway, 309.—Insistent pontoon bridge at the Dublin terminus of the Midland Great Western railway of Ireland, 352.—Bridge on simple triangulation principle, for carrying the Great Northern railway across Newark Dyke, xi. 13.

Canal and river works, iv. 111.—Three incline-planes for boats on the Chard canal, constructed by him (Cubitt, J.), xiii. 210, 213.

Coffer-dam at Great Grimsby, ix. 9.

Dock entrances, vii. 178, 180.—Ditto at the Duke's dock, Liverpool, 180.

Dredging, cost of, x. 293.

Exhibition in 1851, construction of the building for the, x. 191; xi. 147.

CUBITT.

Foundations, method of sinking the cylinders for the, at Rochester new bridge, x. 367.

Harbour and canal at Terneuse, vi. 112.

Horse power, x. 316.

Lighthouses. Bishop Rock lighthouse, ix. 138.—Skerryvore lighthouse, 139.

Permanent way. Compressing wood for treenails, i. (1841) 85.—Cost of a double line of permanent way, and details of the cost of Messrs. Ransome and May's patent chairs, fastenings, &c., 85.—Fracture of chairs, 86.—Reasons for using transverse sleepers, ii. (1842) 75.—Compression of wedges for permanent way by a blow of a piston, 79.—Railway keys, iv. 57.—Construction of permanent way, vi. 80.

Pile-driving, iii. 200.

Pontoon at New Holland, ix. 140.

Railway, atmospheric, iv. 147, 149.

Railway structures, Commission for inquiring into the application of iron to, ix. 137.

Railway system, ix. 141.

Railways. South-Eastern railway, ii. (1842) 75.—Works near Dover for carrying the South-Eastern railway, along the sea-shore, x. 276.

Rivers. Primitive system of navigation practised on the river Stour, in Essex, iv. 111.—Systems adopted on the Clyde, and on the Tees, vii. 246.

Screw-piles and moorings, vii. 144.

Sea defences, construction of, vi. 118.—Concrete sea-walls at Brighton and Dover, 132.—Angle which groynes should make with the shore, and as to their construction, viii. 200.—Effect of the formation of groynes on the South Rocks at Sunderland, 203.—Position and direction of groynes, 204.

Shingle, movement of, on beaches, vi. 133.—Effect of the motion of the water on the shingle on a shore, viii. 204.

Steam boilers, explosion of, i. (1838) 42, 43.

Steam navigation, &c. Table showing the power required to obtain various rates of speed in a steam vessel, i. (1841) 71.—Progress of steam navigation, ix. 139.

CUDWORTH.

- Timber. Specific gravity of timber Kyanized, with and without exhaustion, and under pressure, ii. (1842) 83.—Kyanizing, 85.
- Viaducts. Comparison between the cost of timber and other viaducts, ix. 293.—Failure of the viaduct over the river Nidd, at Knaresborough, x. 236.
- Weirs, oblique, constructed for the improvement of the river Severn, iv. 112, 113; v. 348.—Oblique weir across the Trent, near Long Eaton, 350.—Local peculiarities of the Lincomb weir, on the river Severn, 351.—Proper length for weirs, 352.—Object of the works on the river Severn, and action of the weirs, illustrated by models, 353.—Tabular statement of five weirs in a river 100 feet wide, showing the obstructions caused by them, with remarks thereon, 354.—Results to be deduced from the foregoing, 355, 356, 357, 359.—Effect of long oblique weirs for improving the régime of a river, vii. 245.
- CUDWORTH, J. I'A.
Locomotive engines, adaptation of large extended fire-boxes and combustion chambers (Clark, D. K.), xix. 550.—His system of coal-burning in, 551.
- CUDWORTH, W. [Election, xix. 546.]
- CUNDY, T., Jun. [Election, vii. 75; resignation, x. 72.]
- Cupola furnace for melting iron, ii. (1843) 130.
- CURLEY, T. [Election, xvii. 128.]
- CURLL, W. H. R. [Election, xix. 180.]
- CURRAN, I. [Election, xvi. 46.]
- CURREY, H. [Election, vii. 250.]
- CURSETJKE, A. [Election, i. (1840) 37.]
Marine engines, i. (1840) 68.
- CURTIS, C. B. [Election, ii. (1842) 72.]
Railway signals. "Description of a self-acting signal for railways," ii. (1842) 186.
- CURTIS, J. G. Cockburn. [Election, iii. 66.]
Beacons, floating, for marine surveying, xx. 311.
- Breakwaters, &c. Impossibility of generalizing as to the best form and material for maritime works, xix. 659.

CURTIS.

- Charts, best and clearest mode of drawing up, for different purposes, xx. 347.
- Drainage. Improvement of tidal drainages, xix. 107.—Norfolk estuary works, 107.
- Ferry-boats, American, xx. 388.
- Harbours. Alterations in the coast line at the entrance of Harwich harbour, and hydrological history of the locality, xx. 21.—Progressive increase of Landguard Point from 1804 to 1859, 23.
- Junction of the Atlantic and Pacific oceans. Advantages of the Isthmus of Nicaragua for making a navigation between the Atlantic and Pacific oceans, vi. 429.
- North Sea, want of sufficient information respecting the, to admit of the formation of any correct theory as regarded its hydro-geological history, or the laws of the development and course of the tidal wave within its limits, xx. 349.
- Permanent way. Form of rail found to answer best in Spain, xvi. 383.
- Pier at Southport, Lancashire, xx. 298.
- Railways, guarantees to, in Spain, xviii. 47.
- Rivers and estuaries. Treatment of rivers, xix. 535.—Series of observations on the river Severn in 1843, 536.—Tidal phenomena of the rivers Orwell and Stour at high-water of spring-tides, and comparative configuration of the low-water channels of the two estuaries, xx. 18.
- Ships and steam vessels. Finding the speed of a vessel by heaving the log, iv. 173.—Proposed method of determining the velocity of large vessels, 174.
- Table Bay, Cape of Good Hope, physical features of, xix. 657.—Proposed wave-screen breakwater for ditto, 658, 667.
- Tides. Terms 'spring-range,' 'spring rise,' 'neap range,' and 'neap rise,' xx. 19.
- Timber. Ravages of the 'Teredo' and the 'Terebana,' vi. 54, 55.
- Uniform time, effect of, as regards tidal almanacs, iv. 76.
- Waves, character of, as influencing the

CURTIS.

best form and materials for the construction of sea-walls, vi. 125.—The surf, or shoal-water wave, 126.—Its effect on beaches and artificial sea defences, 127.—Upon the Madras bulwark and breakwater, 127.—Present theoretical division of waves, into waves of translation and of oscillation, xix. 659, 667.—Suggested classification of, 660, 667.—Expedients adopted by the Mount's Bay boatmen, and by the Esquimaux, to break the crest of the surface, or ocean-wind waves, 661.

Weirs, use of, in the improvement of rivers, xix. 536.—Oblique weirs, 540.

CURTIS, T. A. [Election, ii. (1842) 72; resignation, x. 72.]

CURTIS, W. J.

Screw jack. "Description of a traversing screw jack," i. (1840) 60.

Curtis's axle-boxes, notice of, xviii. 444.

Curves, railway, i. (1840) 56; (1841) 96; ii. (1843) 148. *Vide also* RAILWAY CURVES.

CUTHILL, A. [Election, xix. 263.]

CUTLER, —.

Smoke prevention, his system of (Eckstein, D.), xiii. 411.

CUTTINGS.

Birmingham and Gloucester railway, (Jackson, G. B. W.), ii. (1842) 54.

Chalk (Nixon, C.), ii. (1842) 140.

Great Western railway, land slip in Ashley cutting, (Thomson, J. G.), iii. 129. *Vide also* LAND-SLIPS.

Instrument for setting out. "Description of an instrument for setting out the width of cuttings and embankments of railways, canals, or roads, as particularly applicable to falling or side-lying ground." By H. Carr, i. (1839) 52.

London and Croydon, and London and Birmingham railways. "Description

CYLINDERS.

of the method employed for draining some banks of cuttings on the London and Croydon, and London and Birmingham railways; and a part of the retaining wall of the Euston incline London and Birmingham railway." By T. Hughes, iv. 78.—Description of Watson's drain pipes, 78.—Application of ditto to a cutting on the London and Croydon railway, 78.—Ditto, ditto, on the London and Birmingham railway, and cost thereof, 81.—Ditto, to a portion of the retaining wall of the Euston incline, on ditto, 81.

Discussion.—Dockray, R. B., 82.—Rennie, Sir J., 85.—Stephenson, R., 83.

Retaining walls for. "On the introduction of constructions to retain the sides of deep cuttings in clays, or other uncertain soils." By Professor Hoaking, iii. 355.—Struts between retaining walls, 356.—Buttresses to ditto, 356.—Substance of ditto, 357.—Failure of the retaining walls on the London and Birmingham railway, 357.—Method of repairing them, 358.—Hoaking's proposed method, 359.—Comparative cost, 365.—Struts or arched beams between the retaining walls of the Chorley cutting, 367.

Discussion.—Hoaking, Prof., 371.—Pasley, Lieut.-Gen. Sir. C. W., 367.—Vetch, Capt., 369.

South Eastern railway, (Pope, J.), ii. (1842) 72.

Watson's drain-pipes for, (Hughes, T.), iii. 171.

Vide also EMBANKMENTS, LAND-SLIPS, and RAILWAY CUTTINGS and EMBANKMENTS. Cylinders, sunk for wells and for foundations, &c., iv. 248, 249. *Vide also* BRIDGES, FOUNDATIONS OF; and FOUNDATIONS.

D.

DADIAN.

- DADIAN, O. [Election, iii. 101.]
 Iron ores of Samakoff, Turkey, iii. 225.
- DAFT, T. B. [Election, xix. 263.]
 Telegraph cables, use of india-rubber as an insulating material for submarine, xx. 90.—Construction of vessels for paying out deep-sea cables, 90.
- DAGLISH, R., Jun. [Election, xi. 422.]
 Daguerreotype, description of the process of, i. (1840) 58.
- Dahlgren's (Capt.) gun, xix. 383.
- Dal Negro's electro-magnetic engine, xvi. 388.
- DALEYMPLE, G. S. [Election, vii. 326; memoir, xi. 99.]
 Cofferdam. "A description of the cofferdam at the new Houses of Parliament," i. (1840) 18.
- Dalton's rain gauge, ii. (1843) 159.
- Dams, sand used in Holland for, vi. 151.
 —Leslie's plan of constructing, for impounding water, xviii. 389. *Vide* also EMBANKMENTS, WATER SUPPLY, and WATER-WORKS.
- DANIELL, DR.
 River Thames, sanitary condition of, xv. 220.
- DARGAN, W.
 Dublin Exhibition (Annual Report), xiii. 124.
- DARLINGTON, —.
 Hydraulic engines. Water-pressure engine designed by him (Taylor, J.), ii. (1843) 144.—Improvements in the valves, ditto, 144.
- Pump valve, improved by him (Glynn, J.), ii. (1843) 199; (Jordan, J. B.), iii. 90.
- DARLINGTON, J.
 Mines, use of the steam jet for the ventilation of, x. 49.
- Datum line, as to a general, v. 311, *et seq.*
- D'AUBUSSON and CASTEL.
 Water, discharge of, experiments by overfalls at the Toulouse water-works (Blackwell, T. E.), x. 332.

DAVISON.

- DAVENPORT, J. G. [Election, xix. 625.]
 Davenport's (T.) rotary electro-magnetic engine, xvi. 390.
- DAVIDSON, A.
 Decimal coinage, &c. As to retaining the pound sterling as the integer, and altering the farthing, in a new system of decimal coinage, xiii. 339.
- Davidson's (R.), electro-magnetic locomotive, xvi. 391.
- DAVIES, R. L. A. [Election, xviii. 296.]
- DAVISON, R. [Auditor, viii. 44; ix. 90.]
 Asphalte, use of, for floors, ii. (1843) 97.
- Clocks, best materials to be used for the pendulums of, iv. 74.
- Governor for corn mills, v. 265.—Heinrich's governor, 265.
- Horse power. Work performed by brewers' horses in London, and the cost of it, ii. (1843) 117.
- Iron, cast, destruction of, in breweries, ii. (1842) 154.—Causes of the deterioration of iron made with hot blast, ii. (1843) 131.—Comparative strength of castings from hot and cold blast iron, 133.
- Machinery, friction of, ii. (1843) 79.—Experiments with the indicator, 79.
- Machines. "A refrigerator, or machine for cooling brewers' wort," i. (1841) 57.
- Metals. Substitution of gratings of gun-metal for cast-iron, at Messrs. Hanbury's brewery, vii. 158.
- Pipes. Copper pipe filled with deposit from brewers' wort, ii. (1843) 170.
- Timber. "Remarks on the ravages of the worm (*Teredo navalis*) in timber," ii. (1842) 90.
- , Creosoting, xii. 235.
- Process of desiccating, by means of heated air, 235.—Ditto employed for seasoning gun stocks for H. M. Board of Ordnance, 237.—Effect of currents of hot air upon, xii. 239.
- Wells. "Description of the mode adopted

DAVY LAMP.

for sinking a well at Messrs. Truman, Hanbury, Buxton and Co.'s brewery," ii. (1842) 192; ii. (1843) 57.—Remarks, 58.—Depth of various wells in London, and the depression of the water level in them, 165.

Sinking of the water-level in the wells under London, viii. 185.

Davy lamp, vi. 166.

DAVY, Sir H.

Carbonic acid, liberation of, by means of the circulation of the blood (Faraday, Prof.), ii. (1843) 190.

Gas. His investigations on gas lighting (Ure, Dr.), vii. 100.

DAWSON, Captain, R., R.E. [Election, i. (1838) 26.]

Day's (R.) cast-iron base plates, in two parts, xvi. 285, 248.

DEANE, —.

Cheil bank, &c. Shambles shoal off Weymouth, xi. 217.

Coasts. Supposed percolation of chalk water into the sea, xi. 219.

Shingle, size of, xi. 219.

Deane, Adams and Deane's revolver, xi. 56.

DE BEMGE, C. L. A. [Election, viii. 164.]

Permanent way. His cast-iron sleepers for foot-rails (Adams, W. B.), xvi. 250.

—Trial on the Great Northern railway (Burleigh, B.), 275. — His cast-iron sleeper-way, trial length on the Bristol and Exeter railway (Fox, F.), xx. 270.

Water-wheels, construction of, particularly on Poncelet's system, viii. 63.

DECIMAL COINAGE, ETC.

"On the French system of measures, weights, and coins, and its adaptation to general use." By J. Yates, xiii. 272. —Forty-millionth part of the entire meridian adopted as the basis of the measurement of length, and called a *mètre*, 272.—Law relating to it enacted in 1795, 272.—The estimate of weight founded upon the *mètre*, 273.—Coins adjusted on the same principle, 273.—Law of January 1st, 1840, enforcing this system, 273.—Extent to which it has already progressed, 274.—In this country it has only been adopted for scientific purposes, 274.—On the Conti-

DECIMAL COINAGE.

nent the advance towards uniformity has been more rapid, 275. —French philosophers aimed at a method which should be free from any national peculiarity, 275.—The result of Commissions appointed by the British Parliament shows, that it is impracticable to mend our system, 276.—Huygens' observations on the pendulum, 276.—Proposal to make the seconds pendulum the fundamental standard in metrology, 276. —Advantages of systems of arithmetic founded either on the number 8 or 12, 278.—Agencies which may be called into operation to aid the adoption of the new system, 280.—Should be taught in all endowed schools, and schools for the poor, 280. —Modification of the nomenclature, 281.—Mr. H. Taylor's views as to the introduction of a new decimal coinage, 282.—Table of coins and denominations supplying equivalents to all current English coins, 282. —Superiority, in practice, of the decimal mode of computation, 285.—Saving that would result to the Bank of England and similar establishments, 285. —Ditto in keeping the accounts of the London and North-Western railway, 286.—Extension of system to calculations respecting weights and measures, 287.—Diversity in the pharmacopœias of different parts of Europe, and even of the British Islands, 287.—Difficulties presented to foreign merchants by the clashing weights, measures, and coins of this country, 288.—Association to obtain a uniform rate of postage, for letters and parcels, throughout the world, 289. —Government having more to do with weighing, measuring, and counting money than any other body in the kingdom, should adopt new system in their transactions, 289. —Quotation from observations of Dr. Lamont, on the introduction of new weights and measures into Bavaria, 290. —Association of individuals to aid the Government in carrying out system, 291.—APPENDIX I. Extracts from the Report of President Adams

DEEP-SEA SOUNDINGS.

(U.S.) upon weights and measures, 293.—II. French coins and measures of length not in general use, 294.—III. French code relating to weights and measures, 294.—IV. M. Quetelet on the adoption of the French metrical system in Belgium, 294.—V. Decimal moneys of different countries, 295.—VI. Primary importance of the ton, in the series of weights, shown in Mr. Braithwaite Poole's 'Statistics of British Commerce,' 296.—VII. Desirable to provide packages adjusted to the system of weights and measures, and certified to contain specified quantities, 296.—Quotation from 'Report of Commissioners on Standards of Weights and Measures,' as to dispensing medicines, 296.—VIII. Quotation from the Report of President Adams, to show that the French system would have been adopted in the United States had it been encouraged by Great Britain, 297.

Discussion.—Airy, Prof., 304.—Arbuthnot, G., 317.—Babbage, C., 345.—Bidder, G. P., 347.—Brown, W., 299, 316.—Davidson, A., 339.—Good, S. A., 336.—Gray, Dr. J. E., 318.—Lawrie, J., 310.—Manby, C., 336.—Miller, W., 330.—Milward, A., 340.—Morrison, J., 316.—Pasley, Lieut.-Gen. Sir C. W., 302.—Rathbone, T. W., 337.—Simpson, J., 348.—Smith, J. B., 328.—Sparkes, G., 344.—Yates, J., 348.

Deep-sea soundings, want of a good instrument for, xi, 22.

DEES, J. [Election, xiii. 241.]

Defence of Arrah, by Mr. R. V. Boyle, xvii. 165.

DEFENCES, NATIONAL.

Design and construction of steam-ships, of rams, or vessels for running down, of harbours of refuge, of artillery, and of railway access to the coast (Bidder, G. P.), xix. 222.—Points requiring investigation as regards rams, 223.—Harbours of refuge as bases of operations for the navy, and principle of construction employed at Dover, Alderney, Jersey, Holyhead, and Portland, 225.

DEFRIES.

"The National Defences." By G. P. Bidder, Jun., xx. 391.—Expenditure during the eight years from 1853-61, 391.—Should reliance be placed on the navy alone, or part of the resources of the nation be employed in providing a supplementary protection to the shores, by means of fortifications, 393.—Insular position and extensive sea-board of Great Britain, 393.—Changes which the modern improvements in gunnery, and in the application of steam-power to propulsion, have produced, 396.—Material to be used in the construction of ships for the future navy, and objections to the use of iron considered, 396.—Fortification of ships of war by means of iron plates, how far it is advisable and in what manner it should be applied, 397.—'La Gloire' and the 'Warrior' described and contrasted, 397.—Trial trip of the 'Warrior,' 399.—Vessels for Channel service should be built of iron, have one deck only, be very lightly rigged, and carry heavy guns, 400.—Steam rams, 401.—Best mode of dealing with the present navy, and of converting the old men-of-war into efficient ships, 402.

Discussion.—Adair, Col., 409.—Armstrong, Sir W. G., 471, 486, 487, 509, 510, 522.—Aston, T., 496.—Bidder, G. P., 403, 416, 424, 425, 486, 505, 509, 510, 522, 523.—Bidder G. P., Jun., 403, 502, 503.—Clay, W., 487.—Conybeare, H., 458.—Harrison, T. E., 435.—Hawthorn, J., 448.—Jervola, Lieut.-Col., 424, 425, 439, 503, 522.—Lawrence, J., 438.—Longridge, J. A., 500.—Moorson, Capt. W. S., 452.—Russell, J. S., 416.—Sale, Col., 494.—Samuda, J. D'A., 427.—Sartorius, Admiral Sir G. R., 430.—Scott, Commander R., 425.—Simmons, Col., 487.

DEFRIES, C.

Railway-carriage roof-lamps, xviii. 162.

DEFRIES, J.

Gas meters. Dry meter described, iv. 216.—General construction of gas meters, and their relative advantages, 218.

DEFRIES.

- DEFRIES, N.**
Gas meter, dry, ii. (1842) 89.
- DE GREY, Earl.** [Election, i. (1839) 70; memoir, xix. 168.]
- DE LA BOCHE, Sir H.**
Embankments. Hanwell embankment, iii. 168.
Mines, ventilation of, and on compulsory inspection of ditto, vi. 196, 204.
Railway cuttings, iii. 155.—Drainage of the Brentwood cutting, 169.
Slate. His conjecture of the influence of polar forces in the production of slaty cleavage (Tyndall, Prof.), xv. 67.
Stone, artificial, manufacture of, with a silica base, vii. 67.
- DE LA GARDE, P. O.** [Telford medal, v. 2.]
Canals. "Memoir of the canal of Exeter, from 1563 to 1724," (Green, J.), iv. 90.
- DELANEY, E. M. J.** [Election, xx. 292.]
- DELSBUICK, M.**
Metals. "On the autogenous uniting of lead and other metals," i. (1840), 27.
- DEMPSY, G. D.** [Telford medal and premium, i. (1839) 6.]
Rope manufacture. "On Huddart's rope manufacture," i. (1838), 38.
- DENHAM, Captain H. M., R.N.** [Election, x. 244.]
- DENISON, E. B.**
Bells in the Clock Tower at the New Palace, Westminster (James, J.), xix. 5, *et seq.*
Crab. Small crab, or winch, xviii. 231.
Locks and keys. Description of his new lock, xiii. 260.—Remarks, 264.—Small keys for strong locks, 268.—Objections to American permutating lock, 268.
- DENISON, Lieutenant, R.E.** [Member of Council, i. (1838) 20; Telford medal, i. (1839) 8.]
Materials, experiments on the strength of, i. (1837) 28.
Timber. "Experiments on the strength of various kinds of American woods, exposed to a transverse strain," i. (1837) 28.
- DENON, —.**
Isthmus of Suez. His 'Description de l'Egypte' alluded to, as containing

DEODORIZING.

- the report and survey of the ancient canal of Cairo, by M. Lepère, together with his plan and estimate for restoring this ancient navigation (Glynn, J.), x. 371.
- DENROCHE, C.** [Election, i. (1840) 41; Walker premium, ii. (1843) 7; memoir, xv. 103.]
Gas. "Account of the machinery and apparatus for compressing and using gas for artificial illumination at the portable gas-works of London, Edinburgh, Manchester, and Paris," ii. (1842) 137.
- DENT, E. J.** [Auditor, i. (1838) 20; memoir, xiii. 156.]
Clocks, causes of the variation of time in, iv. 74.
- DENTON, J. B.** [Election, ii. (1842) 122.]
Drainage of land. Want of some comprehensive measure for the control of arterial drains and outfalls, xix. 86.—Appointment of a central commission to administer a general Act for the improvement of outfalls, 120.—Cost of obtaining special Acts of Parliament for different drainages, 121.—Effect of under-draining in increasing floods and in diminishing evaporation, 122.
- Drainage of towns. Necessity of regulating the discharge of the refuse of towns into the arterial drains, xix. 88.
- Levelling. "A" level, iv. 403.
- Model mapping. "On the construction of model maps, as a better mode than sectio-planography for delineating the drainage and agricultural improvements of a country, or projected lines of railways, canals, &c.," ii. (1842) 155.
- Water supply. Effect of the under-drainage of land on the supply of water to rivers, xx. 229.—Value of 'clear water,' in the case of Barnard v. Arkwright, 240.—Rights in underground water, 253.
- Deodorizing, and disinfecting chemical preparations, vii. 97.—Nitrate of lead process of M. Ledoyen, 98.—Chloride, or muriate of zinc, process of Sir W. Burnett, 98.—Peroxide of iron, and

DE RICHEMONT.

protoxide of manganese, 98. *Vide* also
DRAINAGE OF TOWNS, and SEWAGE.

DE RICHEMONT, M.

Metals. Autogenous uniting of lead and
other metals, i. (1840), 27.

Derricks. *Vide* CRANES.

DESPARD, R. C. [Council premium, xviii.
174.]

River Lee. "Description of the im-
provements on the second division of
the river Lee navigation; with re-
marks on the position of canals gene-
rally, in reference to the development
of their resources," xvii. 386.—Re-
marks, 408.

Detonating-caps, mode of placing, on the
nipple of a rifle or a musket, xiv.
189.

DEVILLE, J. [Memoir, vi. 5.]

D'HABOUCURT, M.

Permanent way. His artificial granite
for railway blocks, i. (1839) 59.

DICKINSON, J. [Election, i. (1840) 45.]

Brickmaking, ii. (1843) 155.

London basin. Periodical drainage and
replenishment of the water in the
chalk basin of London, ii. (1843) 159.
—Area of the outcrop of chalk through
which water passes to the London
basin, ix. 162.

Rain-gauge, experiments with the, on
the quantity of water which sinks to
three feet beneath the surface of the
soil (Buckland, Dr.), ii. (1842) 159;
(Clutterbuck, Rev. J. E.), 161.—Com-
parative result of two rain-gauges, ii.
(1843) 159.

Water-bearing stratum, green-sand for-
mation as a, ix. 156.

Water supply. Progressive exhaustion
of the wells under London, ix. 156.—
Gauge for ascertaining the quantity of
water delivered into the river Colne,
157.—Table of comparison of rainfall
with that passing through the surface,
158.—Water supply for London, 159.
—Supply of water from a well sunk at
Watford, and from whence it would be
derived, 178.—Physical characteristics
of chalk rock, and on its capabilities as
a water-bearing stratum, 369.—Rate at

DIVING APPARATUS.

which water is absorbed by chalk,
374.—Springs of chalk formation, and
water-bearing properties of that stratum,
xiv. 71.—Gauge used in ascertaining
infiltration of water into chalk, 84.—
Quantity of water in river Colne, 89.
—Effect of pumping, upon wells in
neighbourhood of Plumstead water-
works, 80, 84.

DICKINSON, J. A. [Election, xix. 489.]

Difference engine, Schantz', explanation of
some detailed diagrams of, illustrating
the mechanical notation of Mr. Babbage,
xv. 497, *et seq.*

DINES, T.

Fire-proof buildings. Construction of fire-
proof dwelling-houses, the use of cast-
iron, and effect of fire and heat upon it,
viii. 153, 158.

Girders, Mr. T. Cubitt's experiments upon
the strength of cast-iron, xiii. 471.—
Absence of permanent set in girders the
exception, not the rule, 472.

Machinery in use at the establishment of
the late Mr. T. Cubitt, for the conver-
sion of wood, xvii. 47.

DINNEN, J.

Marine engines, expansion in, the con-
sumption of fuel, the use of steam-
jackets round the working cylinders,
and of superheated steam, xviii. 275.—
Surface condensation, 278.

Steam. Condition of common steam before
superheating, and results of trials in
H.M.S. 'Dee' with common steam, with
steam simply dried, or superheated, and
with mixed, or combined steam, xix.
476.

Steam navigation, &c. Results of a series
of trials on board H.M.S. 'Desperate,'
under different conditions, showing
the indicated H.P., the speed, and the
expenditure of coal per indicated H.P.,
xvi. 333.

Discharge of water. *Vide* WATER, DIS-
CHARGE OF.

Discs of silvered plate glass, mode of bend-
ing into concave, or convex mirrors, by
means of the pressure of the atmo-
sphere (Nasmyth, J.), i. (1840) 31.

Disinfecting and deodorizing agents, vii. 97.

DIVING APPARATUS.

DIVING APPARATUS.

"On improvements in diving-dresses, and other apparatus for working under water." By J. W. Heinke, xv. 309.—Divers in requisition for various purposes from the earliest times, 309.—Rude kind of diving-bell adopted before the sixteenth century, 310.—Submarine vessel proposed by Debrell, in 1620, 311.—Machine proposed by Lord Bacon, in 1645, 311.—Ditto by Bishop Wilkins, in 1648, 311.—Ditto by Marquis of Worcester, in 1663, 311.—Ditto by Borelli, in 1669, 312.—Ditto by Mersennius, in 1671, 312.—Enterprises for searching for treasures hidden in wrecks, &c., 312.—Successful adventure of Phipps, upon the wreck of a Spanish galleon, 313.—Dr. Halley's diving-machine, and extract from his paper on 'The Art of Living under Water,' 313.—Machine invented by Lethbridge, in 1716, 315.—Ditto by Symonds, 315.—Ditto by Triewald, 316.—Ditto by Rowa, in 1750, 316.—Ditto by Day, in 1774, 316.—Ditto by Spalding, in 1775, 316.—Offer of Mr. Bushnell, of Connecticut, in 1775, to destroy the British shipping, 316.—Resuscitation of scheme, in 1822, by Colt, 317.—Diving-apparatus proposed by Martin, in 1778, 317.—Employment of the diving-bell for civil engineering operations by Smeaton, in 1779, 317.—Ditto by Rennie, in 1788, 317.—Kleingert's diving-apparatus, published in 1798, 317.—Diving-machine employed by Messrs. J. and W. Braithwaite for recovering guns from floating batteries, sunk off Gibraltar, and the cargoes of the ships, 'Hartwell' and 'Earl of Abergavenny,' 318.—Diving-bell used at works of Plymouth breakwater, 318.—Attempt to raise the 'Royal George,' sunk in 1782, 318, 319.—Deane's apparatus employed upon the wrecks of the 'Carnbrae Castle,' 'Boyne,' 'Royal George,' and 'Mary Rose,' 319.—General Sir C. W. Pasley's operations upon the 'Royal George,' 320.—Gunpowder fired under water by

DOBSON.

the voltaic battery, 320.—Dr. Payerne's means of restoring the purity of the air under water, without communication with the atmosphere, and experiment at Spithead, 321.—Helmet diving apparatus, 321.—Improvements in ditto by Bethell, in 1835, 322.—Ditto by Bush, in 1836, 322.—Ditto by Frazer, in 1836, 322.—Ditto by Thornthwaite, in 1838, 322.—Ditto by Messrs. Heinke, 322.—Trials with ditto at Portsmouth, Chatham, and Paris, 324.—Award of First Class Medal at Paris Exhibition to Heinke's apparatus, 325.

Discussion.—Belcher, Admiral Sir E. 339.—Bethell, J., 330, 338, 344.—Bidder, G. P., 330.—Gibbs, J., 327.—Giles, A., 326.—Heinke, J. W., 326, 327, 330.—Mallet, R., 339.—Pasley, Lieut.-Gen. Sir C. W., 328, 330, 337, 340.—Pearsall, T. J., 339.—Siebe, A., Jun., 327, 345.—Siebe, A., Sen., 327.—Stephenson, R., 340, 347.—Vignoles, C., 339.—West, —, 327.

Improvements in diving-dresses, and comparison of work performed by divers and diving-bells (Heinke, J. W.), xviii. 149.

Diving bell, experiments with a, i. (1839) 68.—Machinery for working, used at Kingstown harbour, ii. (1842) 148.—Quantity of work done per day, 148.—Dr. Payerne's apparatus for purifying the air in, ii. (1843) 191.—Machinery for working, at the extension of the pier at Kilrush, on the river Shannon, v. 245.—Unsteadiness of diving-bells, vii. 414.—Used in carrying out improvements of the river Newry, x. 234.—Brief records of diving-bell work, 360. *Vide also* MACHINERY.

DIXON, O. [Election, i. (1838) 15; resignation, xiii. 134.]

DIXON, E. [Election, ii. (1842) 56.]

DOBSON, E. [Election, ii. (1842) 72.]

Bridges. "Description of the iron skew bridge across the Regent's canal on the Eastern Counties railway," ii. (1842) 90.

DOBSON, G. C. [Election, i. (1840) 41; Walker premium, ii. (1842) 9.]

DOBSON.

Bridges. "Description of a drawbridge at Bowcombe Creek, near Kingsbridge, Devon," ii. (1843) 68.

DOBSON, S. [Election, xvi. 46.]

DOCK ENTRANCES.

"Remarks on the formation of entrances to wet and dry docks, situated upon a tideway; illustrated by the principal examples in the Port of London." By J. B. Redman, vii. 159.—Practice as to docking a ship in the port of London, 159.—Blackwall entrance of the East India docks, 159.—Docks and slips at Messrs. Wigram's and Messrs. Green's, Blackwall, 160.—Blackwall entrances of the West India docks and of the City canal, 160.—Western, or upper ditto, ditto, 161.—Direction of the building-slips and of the graving-docks at Woolwich dockyard, 161.—Ditto at Deptford dockyard, 162.—Entrance-locks to the East Country dock, and to the Commercial docks, 162.—Messrs. Dowson's graving-dock at Limehouse, 163.—Regent's canal entrance-lock, 163.—Lavender graving-dock, Rotherhithe, 164.—Shadwell entrance of the London docks, 164.—Extracts from Mr. H. R. Palmer's "Report on the proposed eastern entrance to the London docks," including remarks on the entrances to the Bristol and the Runcorn docks, on the docks in the Port of London, and on the entrances to the principal public docks, and the labour entailed at the graving-docks on account of their position, 165.—Entrance to the Grand Surrey docks and canal, Rotherhithe, 167.—Central and upper entrances of the London docks, 168.—St. Saviour's dock entrance, 168.—St. Katharine's dock entrance, 168.—Proposed graving-dock, 169.—Proposed wet dock, 169.—Remarks as to building-slips, 170.—Extracts from the opinions of Mr. Dowson, Mr. Knight, Captain Bond, Captain Evans, Mr. Kinipple, Mr. Green, Mr. Haslip, and Mr. Wigram, on dock entrances in the Port of London, 171.

Discussion.—Brunel, I. K., 182.—Cubitt,

DOCK GATES.

Sir W., 178, 180.—May, O., 178.—Murray, J., 179, 180.—Redman, J. B., 178, 179, 182, 183.—Rendel, J. M., 181.—Rennie, G., 175.—Russell, J. S., 181.—Spence, T. B., 177.—Walker, J., 175, 179.—Young, S., 176.

Dock, floating dry, at Amsterdam (Jackson, G. B. W.), vi. 83.

DOCK GATES.

Monkwearmouth, yellow pine used for, (Harrison, T. E.), xviii. 488.

Montrose. "Description of a pair of iron gates constructed in 1843 for the entrance to the wet dock at Montrose." By J. Leslie, iii. 250.

Discussion.—Oldham, T., 256.—Samuda, J., 256.—Vignoles, C., 256.—Walker, J., 255, 256.

Sevastopol. "Description of the iron gates for the docks at Sevastopol, and of the machinery used by Messrs. G. and J. Rennie in their construction." By W. Shears, vi. 47.—Position of the docks, 47.—Dimensions of the nine pairs of gates, 48.—Detailed description of the largest pair, and of the mode of supporting the leaves, 48.—Reasons for constructing them of iron, 50.—Description of their manufacture, 50.—Ditto of the mode adopted for planing or turning the surfaces, 51.—Ditto of the arrangement of the drilling-machine for boring the bolt-holes, 52.—Calculation of the amount of surface planed, or turned, in the nine pairs of gates, 52.—Appendix, containing explanation of the illustrative plates, 56.

Discussion.—Ayrton, F., 55.—Brunel, I. K., 55.—Curtis, J. G. C., 54, 55.—Field, J., 54.—Moorson, Capt. W. S., 54.—Redman, J. B., 55.—Rendel, J. M., 54, 55.—Rennie, G., 53.—Rennie, Sir J., 54.

Sliding gates (Singels, J. O.), i. (1839) 78.

Southampton (Giles, F.), xvii. 546.

Sunderland (Murray, J.), xviii. 477.

Tackle generally employed for gates and caissons (Simpson, J.), xiii. 463.

Tyne (Harrison, T. E.), xviii. 494.

Victoria (London) (Kingsbury, W. J.), xviii. 451.

DOCKRAY.

DOCKRAY, R. B. [Election, ii. (1843) 183 ; Telford medal, ix. 95.]

Paving of the Birmingham station, ix. 226.—Euston station pavement, mode of laying it, and its advantages, 226, 227.

Permanent way. Various descriptions of railway bars exported from England, and their destination, xx. 280.—Desirability of avoiding the use of chairs, 281.—Mr. Seaton's longitudinal timber road without chairs, 281.

Railway-cuttings, iii. 148.—Slips, 148.—Effects produced by the introduction of Watson's drain-pipes to the retaining wall of the Euston incline, and also the cutting near Chalk Farm bridge, on the London and Birmingham railway, iv. 82.

Railway station. "Description of the Camden station of the London and North-Western railway," viii. 164:—Remarks, 176.—Wall at the Camden station, 176.—Cost of moving goods at ditto, 177.

Roofs. Iron roof over the railway station, Lime-street, Liverpool, ix. 213.

Dockyard, Chatham, v. 40.

—, Deptford, vi. 158.

—, Keyham, sliding caisson at, (Fairbairn, W.), xiii. 144.

—, Sheerness, vi. 159.

Dockyards, arrangement of, vi. 22.

Docks.

Birkenhead, failure in the walls of the Great Float at the, (Abernethy, J.), xviii. 506, 507; (Rendel, A. M.), 506; (Hawksley, T.), 507.—Past history and present state of works (Abernethy, J.), 508.

Dimensions of. Necessity for providing for the accommodation of vessels of an increased size (Rendel, J. M.), xiii. 61.

Floating, or wet docks first introduced at Liverpool about the year 1716 (Rennie, Sir J.), v. 39.—Ports at which they have since been constructed, 39.—On the Thames, successive formation of, (Redman, J. B.), xv. 213.—Dock accommodation at the outports, 215.

Great Grimsby, coffer-dam at, (Neate, C.),

DOCKS.

ix. 1.—Tables showing the full theoretical discharge of water due to the observed heads at the new dock-works at, (Beardmore, N.), 8.—Reasons for the selection of the site of the new docks at, (Rendel, J. M.), 12.—Intended works, 13.

Hartlepool (Casebourne, T.), x. 293.—Excavation of the Victoria dock (Highton, E.), x. 295.

Liverpool, walls constructed of rubble (Bidder, G. P.), x. 239.—Ditto (Rawlinson, R.) xvii. 552.

London. "Description of the port of London, and of the works at the London docks." By R. Richardson, ii. (1842) 59.—The first engineers of, 59.—East and West India, the first engineers of, 59.—Plans for, by Dodd and others, 59.

Middlesbro'-on-Tees (Turnbull, G.), v. 250.

Sevastopol (Shears, W.), vi. 47.—Failure in blowing up the, (Bethell, J.), xv. 336.

Southampton. "On the construction of the Southampton docks." By A. Giles, xvii. 540.—Enclosure of the first dock, 540.—Alterations in the plans, 540.—Enclosure of the whole area, by means of banks thrown up from the excavations and by coffer-dams, and section of wall adopted, 540.—Moving forward of the dock-walls, plans proposed for remedying, and particularly that adopted of tying them back to heavy buttresses of piles by iron bars, 541.—On the mode of construction of dock-walls, 543.—Fall of a portion of the dock-wall in January, 1854, and the circumstance to which it was due, 543.—Form of counterforts, 543.—Coffer-dam used for reconstructing the dock-wall, 543.—First graving-dock, of stone, 544.—Second graving-dock, of brick-work and concrete, 544.—Extension of dock accommodation, by completing the excavation of the area partially cleared in 1840, and by building quay-walls, 544.—Quay-walls constructed of concrete, with a face of Purbeck stone, 545.—

DOCKS.

What is necessary to insure the safety of a dock-wall, 546.—Entrance to the inner dock, by one pair of gates, and plan adopted of working them, 546.—Bridge and foot-bridge across the lock entrance, 547.—Dimensions and particulars of the construction of a large graving-dock of brick, including details of the gates, 548.—Increase in the tonnage entering the docks, 549.—The docks and their appliances as now existing, with a summary of the total expenditure, 550.

Discussion.—Abernethy, J., 553.—Beardmore, N., 551.—Giles, A., 553.—Locke, J., 554.—Murray, J., 553.—Rawlinson, R., 552.

Sunderland. "Description of the groynes formed on the South Rocks, for constructing the new docks at Sunderland." By W. Brown, viii. 186.—Allusion to various plans for the construction of docks both upon the north and south sides of the river Wear, 186.—Enumeration of the works in progress on the south side, 186.—Gradual encroachment of the sea upon the Town Moor, and upon the ground occupied as a fort, led to the erection of timber groynes, 187.—Description of the mode of construction of the first, second, and third groynes erected for the formation and protection of the barrier beach, 188.—Effect produced by and upon those groynes, and by the deposit of excavated material, 188.—Breach in groynes Nos. 1 and 3, at the time of equinoctial tides, during the spring of 1848, 190.—Alteration in the section of the remaining groynes, and mode of construction adopted, 191.—Quantity of material deposited from the site of the dock, half-tide basin, lock-pits, &c., 192.—Boulders of clay slate, from the Cumberland mountains, in the banks, 192.—Manner of forming the beach, 192.—Amount of leakage water met with during the excavation of the docks, 193.—Means of excluding the tidal water, 193.—Laying of the foundation-stone in the half-tide basin,

DOCKS.

and opinion expressed by Mr. R. Stephenson on that occasion, 194.

Discussion.—Bidder, G. P., 203.—Cubitt, Sir W., 200, 203.—Farey, J., 204.—Harrison, J. T., 201, 205.—Lealie, J., 195.—Moorsom, Capt. W. S., 198, 201.—Murray, J., 194, 195, 197, 198, 200.—Redman, J. B., 205.—Rennie, G., 201.—Russell, J. S., 198, 199, 200, 202.—Walker, J., 197.

Sunderland. "On the progressive construction of the Sunderland docks." By J. Murray, xv. 418.—Part I. Shipping trade of the port of Sunderland formerly conducted in the tide-way of the river Wear, 418.—Dock, with tidal harbour, executed in 1838, 418.—Act for the construction of commodious docks between the South Pier and Hendon Bay, obtained in 1846, 419.—General form of the dock, with its basin and approaches, as shown in Parliamentary plan of 1846, 419.—Dock chiefly intended for shipment of coals, 419.—Doubts as regards the efficacy of groynes, for maintaining a beach or barrier against the inroads of the sea, 421.—Three groynes erected for the purpose of testing that principle of construction, 421.—Alteration in the Parliamentary plan, 421.—Contract for the construction of the great dock, with the coffer-dam at its southern end, and the excavations, masonry, &c., of the three entrances let to Messrs. Craven, 422.—Laying of the foundation stone of the half-tide basin, 423.—Mortar made by the company, and sold to the contractor at a specified price, 423.—Method of burning and slacking the limestone, 423.—Quality and cost of the mortar made, 424.—Second area of dock reclaimed from the sea, 425.—Tide excluded from the whole area, before the termination of 1848, 425.—Coffer-dam between the point of jetty No. 4 and the eastern wall of the dock, 425.—Method of constructing the groynes, their general dimensions, cost, and average cost per lineal yard, and per lineal yard of

DOCKS.

coast, 426.—Pumping power employed to overcome the leakage and surface water, 427.—Details of the walls of the half-tide basin, and of the northern side, the west wall, and the east wall, of the great dock, 427.—Methods for shipping coals, 428.—Entrance gates, 429.—Works executed to effect a communication with the river Wear, 429.—Coffer-dam at the mouth of the tidal harbour of the docks, 430.—Engine power employed during the summer of 1849, on the works of the great dock and tidal harbour, 430.—State of the works in June 1850, 431.—Part II. Survey of Hendon Bay, for the purpose of determining the best position for the southern outlet to the sea, 431.—Alteration in Parliamentary plan, 431.—Construction of new groynes and embankments, 432.—Ditto of channel coffer-dams, 434.—Advantage of southern outlet to the sea, in permitting vessels to leave when exit from the river, or the docks communicating with it, is impossible, 436.—Sea channel kept free from deposits of sand and gravel, by means of scouring culverts, 437.—Hydraulic apparatus for opening and shutting the sluices, the entrance gates, the railway bridge, &c., 439.—Wrought-iron bridge across the inner entrance, 439.—Details of entrance gates, 440.—Part III. Works for the southern extension of the docks, 441.—Jetties for the shipment of coals, 441.—Graving dock, 443.—Total expenditure, 443.—Areas of the docks and basins, breadths of the entrances, depths of water on the cills, and observations on the rise and fall of the tide at Sunderland, 443.

Discussion.—Bidder, G. P., 453.—Brunel, I. K., 449.—Gibbs, J., 451, 453, 455.—Murray, J., 445.—Oldham, T., 451.—Rendel, J. M., 449.—Stephenson, R., 445, 455.—Webster, T., 452.

Tyne. "On the Tyne docks at South Shields; and the mode adopted for shipping coals." By T. E. Harrison, xviii. 490.—General description of the site,

DOCKS.

and of the works, 490.—Nature of the foundations, 491.—Construction of a large culvert round the head of the works, 492.—Rise in the floor of the north lock, 492.—Plan adopted for rearing a quay-wall and embankment on one part of Jarrow Slake, 493.—Experiments as to the sustaining power of the Slake, 493.—Position in which the entrance to the tidal basin is placed, with reference to the course of the river, 494.—Nasmyth's steam pile-engines used in constructing the river-wall, 494.—The wrought-iron dock-gates, and mode of constructing the invert of the lock, 494.—The sluices, 495.—Provision made for the permanent discharge of a quantity of muriatic acid from the alkali-works, 495.—The shipment of coals, 496.—Account of the various modifications which have been made in the method of shipping coals during the last forty-seven years, 496.—By 'keels,' 497.—By 'spouts,' 497.—By 'drops,' 497.—System of 'spouts' adopted at the Tyne docks, their arrangement, and the mode of adjusting them to the level of the vessels, 498.—The shipping places and jetties, 499.—Mode by which the working is carried on by gravity, 500.—The coal-waggons, 502.—Quantity, and variety, of the coals shipped, 502.—Staff employed for the purpose, 502.—The ballast-cranes, 503.

Discussion.—Abernethy, J., 506, 507, 523.—Bidder, G. P., 520, 523.—Brooks, W. A., 512, 513.—Cowper, E. A., 508.—Giles, A., 504.—Harrison, T. E., 504, 514.—Hawkshaw, J., 522.—Hawksley, T., 507.—Johns, J. W., 511.—Murray, J., 505.—Rawlinson, R., 512.—Rendel, A. M., 506.—Rennie, Sir J., 520.—Robertson, A. J., 513.—Scott, M., 509.—Stephenson, R., 522, 523.

Victoria (London). "Description of the entrance, entrance lock, and jetty walls of the Victoria (London) docks; with a detailed account of the wrought-iron gates and caisson, and remarks upon the form adopted in their con-

DODDS.

struction." By W. J. Kingsbury, xviii. 445.—Situation and general extent of the docks, 445.—Entrance and entrance-lock, 446.—Upper and lower gate platforms, 448.—Sluice-pipes and sluices, 450.—The wrought-iron gates, 451.—The pivot-cross and the pivot, 454.—The shutting-cill, 455.—The roller and roller-path, 456.—The anchor, 457.—Difference between the lower and the upper and inner gates, 457.—The caisson, 458.—Casualties, 461.—Fracture of the shutting-cill, 461.—Subsidence of the side walls of the lock-chamber, 462.—Fracture of the pivot-casting, 464.—Abrasion and splitting of the roller-path, 466.—On the construction of the jetties, 466.—On the advantage of the cylindrical form of lock-gates, 469.—Explanation of the term cylindrical gates, or gates of continuous curvature, 469.—Remarks on the strains to which lock-gates are exposed, and on the mode of calculating them, 469.—Comparison of the quantity of material required in the construction of straight and of curved gates, 471.—Advantage of the uniform thickness of plates, in the same horizontal section, in the cylindrical form, 475.—Inconveniences of the cylindrical mode of construction, 476.

Discussion.—Abernethy, J., 477.—Bidder, G. P., 482, 488.—Bramwell, F. J., 481.—Cooper, J., 481.—Giles, A., 479, 482.—Hawkahaw, J., 488.—Humphrys, E., 488.—Hurwood, G., 488.—Kingsbury, W. J., 479.—Locke, J., 489.—Murray, J., 477, 479.—Rawlinson, R., 481.

Vide also CAISSON, SLIDING.

DODDS, I. [Election, i. (1839) 59.]

Water-wheels. "On improvements in water-wheels," i. (1838) 4.

DODDS, T. W. [Election, xiii. 388.]

DODSON, A. J. [Election, ii. (1843) 183; Walker premium, iv. 4.]

Hydraulic machinery. "Description of the hydraulic traversing frame at the Bristol terminus of the Great Western railway," iii. 128.—Remarks, 129.

DORMAN.

Dogger bank, formation of, and the currents over it, xx. 319, *et seq.*

DONALDSON, G. [Election, ix. 303; Council premium, xii. 116; memoir, xix. 186.]

Drainage of towns. "An account of the drainage of the town of Richmond, Surrey, under the authority of the Metropolitan Commissioners of Sewers, in 1851," xi. 407.—Remarks, 413, 420.—As to utilizing sewage manure of Richmond, 414.—Argument that general system of sewers is somewhat analogous to pipes for water supply, xi. 421.

— Causes of partial failures of earthenware-pipe sewers, xii. 42.—Failures of pipe sewers at Croydon, 42.—Drainage of the district south of the Thames, xiii. 108.

DONALDSON, Professor.

Stone, artificial, manufacture of, with a silica base, vii. 63.

DONKIN, B. [Vice-President, i. (1837) 15; (1838) 20; (1839) 27; (1840) 36; (1841) 52; ii. (1842) 51; (1843) 67; iii. 6.]

Balls. "Description of Mr. Henry Guy's method of giving a true spherical figure to balls of metal, glass, agate, or other hard substances," i. (1837) 22.

Beams, as to determining the position of the neutral axis of, i. (1841) 121.

Bridges, suspension, construction of, i. (1841) 80.

Lighthouses. Bracing of the Maplin Sand lighthouse, ii. (1842) 152.—Construction of iron lighthouses, vii. 156.

Locomotive engines, American, i. (1840) 48.

Machines. Counting-machine, ii. (1842) 167.

Materials, strength of, i. (1837) 29.

Steam boilers, explosion of, i. (1841) 114.

Steam engines, duty of, i. (1840) 22.

DONKIN, J. [Memoir xiv. 130.]

Boilers, cause of priming in, viii. 176.

DONKIN, T. [Election, vi. 213.]

DORAN, J. G. [Election, ii. (1842) 165.]

DORMAN, W. H.

Steam, superheated, xix. 484.

DOUGLAS.

- DOUGLAS, G.
 Locomotive engines, his system of coal-burning in, Birkenhead railway (Clark, D. K.), xix. 551, *et seq.*
 Douglas' fish-joint chair, with Greaves' surface packed sleeper, xi. 253.
 DOUGLASS, J. N. [Election, xx. 258.]
 DOULL, A. [Election, iv. 372; Auditor, xvi. 85; xvii. 68.]
 Electric telegraph. Assumed liability of telegraph posts to accidents, xi. 377.
 Exhibition in 1851, construction of the building for the, x. 185.
 DOULL, A. Jun.
 Life-boat, Forbes' cylindrical, for ships, xii. 24.
 DOULTON, F.
 Pipes, earthenware, manufacture of, xii. 59.—Results of a series of trials, for ascertaining the strength of pipes, 63.
 Drainage of towns. Extract from a letter from Mr. Phillips, as to drainage of Rugby, xii. 62.
 Dovetailing-machines, xvii. 34.
 Dowelling timber, on a mode of, or of combining it, and other materials for general purposes (Brunel, Sir M. I.), i. (1840) 6.
 DOWNES, C. J. [Election, xiii. 383.]
 DOWNING, R. [Election, xvii. 195.]
 DOWNING, S. [Election, xi. 299.]
 DOTY, W. T. [Election, viii. 164; Council premium, x. 66; xii. 116.]
 Beams. Reason for his advocacy of lattice construction, xi. 10.—Series of experiments on beams of every section, in wrought and cast iron, and proposed new formula for breaking weight, taking into account value of middle web, xiv. 463.—Rule for calculating strength of cast-iron beams, 488.—Practical rule for calculating the strength of cast-iron beams under transverse strain, xvi. 77.
 Bridges. "Description of a wrought-iron lattice bridge, constructed over the line of the Rugby and Leamington railway," ix. 358.—Remarks, 357.—Experiments on the strength of rivets,

DRAINAGE.

- 357.—Cost and advantages of boiler-plate bridges, compared with the above, 359.
 — Railway bridge on the lattice principle, over the river Taff, xi. 11.—Ditto, compared with box-head beam girder, 11.—Reasons for adopting lattice form instead of simple triangulation, 11.—Bridge at Ballysimon, on the Waterford and Limerick railway, 12.—Lattice bridges, 434.
 Girders. Relative practical value of different methods of constructing middle web of a girder, and mathematical principles upon which proportions depend, xiv. 460.—Experiments on two cast-iron girders, 462.—Non-accordance of breaking-weights of ditto, with results deduced from Mr. Hodgkinson's rule, 462.
 Permanent way of mineral lines in South Wales, xvi. 383.
 —, and BLOOD, W. B.
 Beams. "An investigation of the strains upon the diagonals of lattice beams, with the resulting formula," xi. 1.
 Drag, safety, or apparatus for preventing accidents to trains ascending incline planes, used on the Edinburgh and Dalkeith railway since 1832 (Rankine, W. J. M.), iii. 284.
 DRAINAGE.
 Ancholme Level. "An account of the drainage of the level of Ancholme, Lincolnshire." By Sir J. Rennie, iv. 186.—Account of the district, 186.—Its geology, 186.—Source and tributaries of the river Ancholme, 186.—Water in the streams, 187.—Early records, 188.—Management, 189.—Early attempts at drainage, 190.—Mr. Rennie's plan for drainage, 190.—System of 'catch-water' drains, 191.—Separation of drainage from navigation, 192.—Sir John Rennie's plans, 193.—Bridges and other works constructed, 193.—Sluice-gates, 196.—Bridges over the navigation, 198.—Completion of the works, 199.
 Discussion.—Cayley, Sir G., 209.—Farey, J., 205.—Giles, F., 201, 202, 209.—

DRAINAGE.

- Oldham, J., 200.—Rennie, Sir J., 200, 201, 202, 209, 211.—Smith, J., 202, 204.—Stephenson, R., 201, 203.
- Arterial. "On arterial drainage and outfalls." By R. B. Grantham, xix. 53.—Extract from Mr. Simpson's address, as to land drainage, 53.—Want of a combined system of operation prevents the adoption of arterial drainage, 54.—Pipe or underground drainage, the advantage and extent of, 54.—Obstructions caused by mills, weirs, &c., 56.—Proposal for draining marsh land at Wareham, and the estimated cost of the several projects, 56.—Results of the drainage works in Ireland, with detailed particulars of five examples, 62.—The Bedford level, its extent, and the characteristics of the rivers draining the district, 65.—Means adopted to reclaim the South level, 66.—Ditto the North level, 67.—Ditto the Middle level, 70.—Drainage of the Ancholme level, 75.—Principles of improving rivers in flat countries, 76.—Drainage districts in Yorkshire, 77.—Reclamation of Hainault forest, by underground and arterial drainage, 78.—System of dealing with rivers in India, particularly in the Madras Presidency, and the irrigation works in connection with them, 80.—The improvement of rivers in Italy, especially those discharging into the plains of Lombardy, and the irrigation works in Northern Italy, 82.—Principles of improving upland rivers and streams, 83.—Commissioners of Sewers for repairing sea-banks, 84.
- Discussion.—Barry, F., 104.—Beardmore, N., 114.—Bidder, G. P., 105, 125, 127.—Brooks, W. A., 106.—Clutton, J., 88.—Clutton, W. J., 113.—Cooper, J., 101.—Curtis, J. G. C., 107.—Denton, J. B., 86, 120.—Fowler, J., 99.—Grantham, R. B., 122.—Hawksley, T., 115, 126.—Hemans, G. W., 103.—Jones, J. H., 125.—Leach, S. W., 111, 112.—Locke, J., 86, 111, 112.—Manning, R., 119.—Orniston, T., 110.—Rennie, Sir J., 90, 101, 112.—Simpson, J., 89.

DRAINAGE.

- Bedford level, description of the works of Cornelius Vermuyden for draining the, v. 43.—Defects in the river Ouse, 44.—Means designed to remove them, by Bridgeman, in 1724, by Mylne and Page, in 1792, and by Rennie in 1817, 45.—Description and effect of the Eau Brink Cut, 45.—Ditto of the works for the improvement of the Nene Outfall, 46.—Ditto of the East, West, and Wildmore Fens, 47.
- Holland (Jackson, G. B. W.), vi. 97.—Compared with Bedford level (Walker, J.), 110. *Vide also* CANALS, Great North Holland.
- Improvement of. "On the improvement of the roads, rivers, and drainage of the counties of Great Britain." By R. Sibley, i. (1841) 100.
- Lee, river, works recently executed on the tidal portion of, (Beardmore, N.), xiii. 241. *Vide also* RIVERS (Lee).
- Principles of drainage and navigation (Rennie, Sir J.), v. 48.
- Rhynland district (Holland), (Conrad, F. W.), ii. (1842) 172. *Vide also* CANALS, Katwijk.
- Roman works for, in England (Rennie, Sir J.), v. 48.
- Smeaton's improvements in, (Rennie, Sir J.), v. 21.
- Steam, first introduced by the late Mr. Rennie at Bottisham Fen, near Ely (Rennie, Sir J.), v. 48.
- Tidal, improvement of, (Brooks, W. A.), xii. 1.—Influence upon the drainage of a country, of works constructed for the improvement of navigation, 11.—Want of attention to question of outfall (Simpson, J.), xiii. 200.—Importance of designing the outfall in harmony with the natural deep-water channel (Curtis, J. G. C.), xix. 107. *Vide also* RIVERS and ESTUARIES.
- Wandle river (Braithwaite, F.), xi. 191. *Vide also* RIVER WANDLE.
- Drainage of railway works, Birmingham and Gloucester, ii. (1842) 54.—Advantage of, on South Eastern railway, 78.—London and Croydon, and London and Birmingham, iv. 78.

DRAINAGE.

DRAINAGE OF TOWNS.

Berlin (Wicksteed, T.), vii. 91.

Bristol. "Account of the recent improvements in the drainage and sewerage of Bristol." By J. Green, vii. 76.—Results arising from the formation of the floating harbour, in 1805, 76.—New sewer from the Froome, passing under the bed of the float, and delivering itself into the new cut made for the Avon, 77.—Characteristics of the river Froome, 77.—State of the Froome, arising from the sewerage, and measures necessary for abating the nuisance, 79.—Works directed to be carried into execution, 80.—Order of execution, and cost of the works, 82.—Benefits the works have produced, 84.

Discussion. — Braithwaite, F., 101. — Buckland, Dr., 84, 92.—Chadwick, E., 95.—Green, J., 87.—Grosvenor, Lord R., 86.—May, C., 100.—Peto, Sir S. M. Bart., 94.—Simpson, J., 94.—Smith, J., 87.—Ure, Dr., 97.—Walker, J., 104, —Wicksteed, T., 90, 102.

Croydon. Extract from reports of Dr. Arnott and T. Page, on the prevalence of disease at Croydon, and as to the plan of sewerage, xii. 44. *Vide* also RIVER WANDLE.

Edinburgh. "Description of the new sewer in the valley of the Cowgate, Edinburgh." By G. Smith, i. (1841) 157.

Hamburgh, xiii. 78, *et seq.*

Holborn and Finsbury. "On the causes of accumulation of deposit in sewers, and on the hitherto generally prevalent mode of removing the same; with a description of a new flushing apparatus used for cleansing the sewers in the Holborn and Finsbury divisions." By J. Roe, ii. (1842) 132.—Length of sewers in the Holborn and Finsbury divisions, 132.—Of the same forms and inclination, different degrees of accumulation exist in, 132.—Flow of water through, 132.

Ipswich. "Description of a plan, adopted for carrying off an accumulation of water from the warehouses, cellars,

DRAINAGE.

&c., near the wet dock at the port of Ipswich." By G. Hurwood, ii. (1843) 183.

Metropolitan district south of the Thames.

"On the drainage of the district south of the Thames." By J. T. Harrison, xiii. 64.—Peculiarity of the Surrey and Kent sewers district, 65.—Description of the tract of land under consideration, 65.—Difficulties to be encountered, 66.—I. The drainage of the land, 66.—II. The interception of the high-land waters, and their conveyance, at all times of the tide, freely to the river, so as to prevent their reaching the low-lying district, 67.—III. The arrangements for conveying away the sewage of the houses, 68.—Means of conveyance from the houses into the public street, and thence to the ultimate destination of the sewage matter, 69.—How to convey the sewage of the low-lying parts of Surrey and Kent to the Greenwich marshes, 70.—The operation of flushing, 71.—Means of conveying the sewage from the houses to the main sewer, 71.—Collateral drains into which the house-drains empty, and which themselves discharge into the cross-drains, 72.—Provision for conveying away the rain-water, 73.—Proposal for making use of the tidal rise of the Thames, for a general system of flushing the sewers in the low-lying districts, without the intervention of steam-power, 73.—Extracts from Prof. Gordon's description of Captain Vetch's plans for the sewerage of the metropolis, as proposed in February, 1850, 74.—Levels of the existing sewers, 75.—Proportion of open stagnant ditches in existence, over the district, to the closed sewers, 75.—Should pumping be adopted, 76.—Chief cause of the sewage of London being a nuisance, 76.—Quantity of sewage matter to be provided for per day, 76.—Advantages of the pipe-drain system for the house-drains and collateral sewers, 77.—Extract from Mr. Bazalgette's Report on the

DRAINAGE.

- drainage of the district south of the Thames, 77.
- Discussion.—Bazalgette, J. W., 92, 100.—Bidder, G. P., 78, 108, 115.—Donaldson, G., 108.—Errington, J. E., 118.—Fowler, C., 78, 107.—Harrison, J. T., 81, 99, 101.—Hawkshaw, J., 110, 117.—Hawksley, T., 95, 109.—Haywood, W., 88, 98, 117.—McClean, J. R., 83.—Manby, C., 79, 118.—May, C., 99.—Moorsom, Capt. W. S., 98.—Pallatt, A., 97.—Phillips, J., 94.—Rendel, J. M., 78, 83, 100.—Roe, J., 96.—Simpson, J., 81, 94, 100, 111, 118.—Vignoles, C., 100.
- Metropolitan (Annual Report), xiv. 100.—Progress of the main drainage, xix. 133. *Vide also RIVER THAMES.*
- Principles and practice of. "On the drainage of towns." By R. Rawlinson, xii. 25.—Town drainage considered historically, politically, and socially, 25.—Extension of towns in Great Britain, and effect in producing disease, 26.—Quotation from report by the Registrar-General on Cholera in England, 27.—Discrepancy of practice in town-drainage works, 27.—Primary considerations in town drainage, 28.—Rules relative to town sewers, 29.—Town sewers should not receive suburban waters, or excessive suburban rainfall, 31.—Questions to be considered in arranging a system of town drainage, 32.—Best form for sewers and drains, 34.—Materials of which sewers may be constructed, 35.—Dimensions of house-drains, 35.—Modes of joining earthenware-pipe sewers, 36.—Use of man-holes in a system of sewers and drains, 38.—Trapping of street gullies, 38.—Ventilation of sewers, 39.—Rules for town drainage, 39.
- Discussion.—Baylis, B., 82.—Bazalgette, J. W., 66.—Bidder, G. P., 88.—Cawley, C. E., 79.—Cliff, J., 78.—Donaldson, G., 42, 43.—Doulton, F., 59.—Duncan, T., 69.—Ebrington, Lord, 44.—Evans, J., 81.—Francis, A., 78.—Gibbs, J., 94.—Hawksley, T., 57, 58.—Haywood,

DRAINAGE.

- W., 45, 68.—Lovick, —, 69.—May, C., 83.—Murray, J., 53.—Netherway, —, 59.—Newlands, J., 90.—Newton, —, 95.—Parker, —, 66.—Plum, —, 82.—Rawlinson, R., 41, 43, 45, 53, 58, 100.—Rendel, J. M., 106.—Ritchie, R., 65.—Simpson, J., 92.—Smith, T., 69.—Stephenson, R., 84.
- Principles and practice of (Simpson, J.), xiii. 199.—Influence of errors of Trial Works' Committee of Metropolitan Sewers Commission upon practical operations (Bidder, G. P.), xiv. 289, *et seq.* *Vide also WATER, flow of, through pipes.*
- Necessity of regulating the discharge of the refuse of towns into the arterial drains (Denton, J. B.), xix. 88.—Prospect of the sewage of towns being employed for the fertilisation of land (Bidder, G. P.), 220.—Effect of the discharge of sewage into rivers, 232, *et seq.*
- Richmond. "An account of the drainage of the town of Richmond, Surrey, under the authority of the Metropolitan Commissioners of Sewers, in 1851." By G. Donaldson, xi. 407.—Orders from Commissioners to use tubular stoneware pipes for sewers, 408.—Separation of surface and storm waters, 408.—Gradients of different sewers, 408.—Extent of works, 409.—Junctions with main sewers, 409.—Sockets and joints of pipes, 410.—Cost of works, 410.—Flow of water through sewers, 410.—Sizes of pipes adopted, 411.—Where stoneware pipes may be used, 411.—Proper sizes for sewers, 412.—Flushing sewers, 413.
- Discussion.—Bazalgette, J. W., 415.—Donaldson, G., 413, 415, 420.—Hawksley, T., 416.—Haywood, W., 414, 420.—Hertault, C. L., 413.—Hosking, Prof., 416.—Lavers, W., 419.—Lealie, J., 419.—Rendel, J. M., 421.—Simpson, J., 419.—Stephenson, R., 420.—Thorold, W., 414.
- Self-acting penstock, or flushing-machine (Salter, R.), xvi. 43.
- Surface drainage and sewerage in England,

DRANE.

history of, (Rennie, Sir J.), v. 61; vi. 23.

Westminster. "The sewage of the City of Westminster, described and delineated." By J. E. Jones, i. (1839) 63.—The history of sewage, 63.—The principles of, as applied to the City of Westminster, 64.—Description of the illustrations to the account, 65.

DRANE, T. [Election, xi. 422.]

Drawbridge at Bowcombe creek (Dobson, G. C.), ii. (1843) 68. *Vide* also BRIDGES.

Drawing and modelling, v. 113.

Drawing instruments. Screw helicograph, or logarithmic spiral compass, and Penrose and Bennett's sliding helicograph, x. 245.

DREDGING-MACHINES.

American excavator, adaptation of, (Hyde, J. B.), iv. 399.

Floating clough. "Description of a machine called a floating clough." By G. Ellis, i. (1839) 48.

Steam. "Description of a steam dredging engine, used upon the Caledonian canal." By W. Elliot, ii. (1842) 149.—Excavators superseded by, 150.—Quantity of work done per day by it, 150.—Speed of the buckets, 150.—Expenditure of coal, 150.

Vertical scraper frame. "Account of a machine for cleansing and deepening small rivers, in use on the little Stour river, Kent." By W. B. Hays, i. (1837) 26.

Dredging operations, for forming the harbour at Nieuwediep, vi. 108.—Ditto at Sunderland, &c., 276, 279.—Ditto river Newry, x. 284.—Cost of dredging, 293.

DREW, E. A. [Election, xiii. 421.]

Drift, masses of, covering the regular stratification, iii. 134.—Deposits of, in Staffordshire, 134.—Ditto in Lancashire, 152.

Driftways. *Vide* TUNNELS.

Drops, coal, erected at South Shields (Harrison, T. E.), i. (1837) 37.—Ditto at Middlesbro' on Tees (Turnbull, G.), v. 248.—Ditto at the Tyne docks (Harrison, T. E.), xviii. 496.

DUNN.

DRUMMOND, W.

Drainage of towns. Works undertaken and carried out by the Local Board of Health for the improvement of the drainage of Croydon, and state of the river Wandle before and after the completion of the works, xx. 238.

Water supply. Question of rights in underground water, xx. 252.

DRYSDALE, A. [Election, vii. 184.]

DRYSDALE, C. B. [Election, xiv. 42; Telford medal, xvi. 92.]

Railway inclines. "On steep gradients of railways, and the locomotives and stationary engines employed," xv. 349.—Remarks, 374.—Means of working railway incline-planes, 374.

DU BUAT, —.

Water, discharge of. His experiments on the passage of water over weirs (Blackwell, T. E.), x. 332.

Dublin Exhibition, xii. 243.

DUMAS, M.

Iron, report to the French Academy on zincing (Pellatt, F.), ii. (1843) 168.

DUNCAN, —.

Drainage of towns. Stoppage of line of pipe sewer at Kilburn, xii. 69.

DUNCAN, T. [Election, vii. 366; Telford medal, xiii. 127. 162.]

Water-works. "Description of the Liverpool Corporation waterworks," xii. 460.

Duncan's crossing point, ix. 233.

Dundee, harbour of, i. (1840) 10.

DUNDONALD, Earl of.

Steam boilers. "On the results of the use of tubular boilers, or of flue boilers of inadequate surface, or imperfect absorption of heat," xi. 388.

Pitch lake of Trinidad (Gordon, A.), xi. 383.

DUNKIN, R. [Election, iii. 342.]

DUNN, J. B. [Election, xix. 139.]

DUNN, M.

Mines, ventilation of, especially those in the Newcastle district, vi. 183.—Safety-lamp, 184.

DUNN, T. [Election, xiii. 383; Council premium, xvii. 80.]

Machines. "On chain cable and timber-

DURHAM.

testing machines," xvi. 301.—Remarks, 307.—Cost of ditto, 307.

DURHAM, —.

Steel from the hæmatite ores of Turkey, iii. 247.

Du Trembley's combined vapour engine (Jameson, J. W.), xviii. 233.

Duty reports. Constant indicator upon Cornish engine at East London water-works (Moseley, Prof.), ii. (1842) 102. —Advantages of constant registration of, 106.—Duty reports in Cornwall, 108.

'Dwarf,' experiments with the screw propeller in the, iii. 73.

DYE, C. H.

Fuel. Formation of clinker, xiv. 18.

DYER, J. C. [Election, i. (1840) 68.]

DYKES, D. S. [Election, xv. 418; memoir, xvii. 99.]

Dykes, Katwÿk, ii. (1842) 172.—Of Spaarn-dam, Marendÿk, &c., 172.—Koegrass

DYSON.

Sea, on the Great North Holland canal, mode of construction and dimensions of, vi. 91. 96.—At Nieuwediep.—General construction of the dykes round the polders, 121.

Dymchurch wall (Elliott, J., Jun.), vi. 466. *Vide also* SEA DEFENCES.

DYNAMOMETERS.

"Description of a dynamometer, or an instrument for measuring the friction of roads, railways, canals, &c." By H. Carr, i. (1840) 52.

— Experiments with Prony's friction braks (Gordon, Prof.), ii. (1842) 95; (Bennie, G.), 101.—Dynamometer by Poncelet and Morin (Moseley, Prof.), 106. — By Davies of Birmingham (Parke, J.), 114.—For measuring the traction on railways, and on board vessels, &c. (Russell, J. S.), v. 281; vi. 142.

Dyson, G. [Election, xvi. 226.]

E.

EARDLEY-WILMOT.

EARDLEY-WILMOT, Colonel, R.A.

Artillery, construction of, xix. 403.—Mr. Longridge's wire-bound gun, Capt. Blakely's hooped gun, and Sir W. Armstrong's and Mr. Whitworth's breech-loading guns, 403.—Results of experiments with a Spanish cast-metal 32-pounder, 404.—Ditto with an American shell-gun, 404.—Cast-iron guns, 405.—Royal Gun Foundry at Woolwich, 405.—Rifling of the old service guns, 406.—Brass guns, 406, 423.—Sir W. Armstrong's new breech-loading gun, 422.

Iron and steel, Bessemer process for the manufacture of malleable, xviii. 550.

Earth-boring machine, Messrs. Mather and Platt's, xiv. 523.

Earth-falls at the Undercliff in the Isle of Wight (Rickman, W.), i. (1840) 35.

Earth-work, peculiar mode of formation on the Amsterdam and Rotterdam railway, iii. 175, 179.

EASTON, A. [Memoir, xiv. 131.]

EBBINGTON, Lord.

Drainage of towns. Pipe sewerage at St. Thomas, Exeter, xii. 44.

ECKERSLEY, W. [Election, xiii. 383.]

ECKSTEIN, D.

Smoke, prevention of, Cutler's system for the, xiii. 411.

Edystone lighthouse, effect of hydrostatic pressure on, i. (1841) 115.

EDINGTON, —.

Fire-proof buildings. Construction of the mill at Newry, xii. 268.—Safest construction for warehouses, 269.

Education of civil engineers, ii. (1842) 23.

— of working classes in America and England, xi. 61, 63.

Edwards, M., extract from his "De l'influence des agents physiques sur la vie," ii. (1843) 190.

EDWARDS, G. [Telford medal, v. 2.]

Blasting under water. "The application

ELDRIDGE.

of gunpowder as an instrument of engineering operations, exemplified by its use in blasting marl rocks in the river Severn," iv. 361.—Remarks, 370.—Bickford's fuse and reasons for preferring it to the galvanic battery, 370.

Bridge, foundations of, over the Haddisco Cut, near Lowestoffe, vi. 157.

River Wear, mode of testing the deposits in the, vi. 283.

Sea defences, use of fascines in Holland and in England, vi. 117.—Cultivation of a species of rush for preventing the light sand from being blown, &c., 117.—Advantages of the use of groynes as coast defences, 144.

Steam. "A steam expansion table," i. (1837) 24; (1838) 42.

Timber, nature and ravages of the 'Teredo navalis' and the 'Limnoria terebrans,' and means of protecting, ix. 45.

EDWARDS, H. H. [Election, xv. 47.]

EDWARDS, S.

Machinery, mineral and coal washing, xvii. 218.

EDWARDS, W. (Architect of the Pont-y-tu-Prydd.) Memoir (Smith, T. M.), v. 475.

Efflux of gaseous fluids under pressure (Hood, C.), i. (1840) 87.

Eidograph, by Professor Wallace, i. (1839) 65.

ELDRIDGE, Captain.

Naval construction, &c. Ship-building in America and in England, xiv. 408.

Steam navigation and auxiliary power to sailing-vessels, xiv. 391.—First voyage of the 'Red Jacket,' from New York to Liverpool, 391.—Comparative advantages of sailing-vessels with and without screw-propeller, 392.—First voyage of the 'Pioneer,' 392.—American clipper ships, 392, 406.—Steam-ship 'Great Britain,' 407.

ELECTRICITY.

- Electricity. When metals are in contact, the negative metal is protected at the expense of the positive, ii. (1843) 168.—Connection of, with the corrosion of metals, 174.—Action of, on earths and rocks, iii. 150.
- applied to blasting rocks, &c. v. 104, 105. *Vide* also **BLASTING**.
- , galvanism, magnetism, and light, vi. 26.
- , passage of, by submerged wires, as compared with that by suspended wires, xvi. 196.—Table of the measured velocities of, upon metallic conductors, 198.
- *Vide* also **ELECTRIC TELEGRAPHS**, and **TELEGRAPH CABLES**.

ELECTRIC TELEGRAPHS.

- Application of electricity by Professor Wheatstone (Walker, J.), ii. (1843) 30.
- Description of a pair of electro-magnetic telegraphs for the Aix la Chapelle railway (Wheatstone, Prof.), 181.
- The earth, or an extent of water used to complete the circuit, 182.—One wire dispensed with, 182.—Experiments upon, by Watson, Erman, Basse, Aldini, and Steinheil, 182.—Dates of placing electro-magnetic telegraphs, 182.—An electro-magnetic machine, substituted for a voltaic battery, 183.

Berlin to Hamburg (Siemens, C. W.), xi. 362.—Berlin Town telegraph, 363.

Description of the invention (Rennie, Sir J.), v. 103.—Notice of Mr. Ronald's, 103.—M. Ampere's, 104.—Cooke and Wheatstone's, 104.—Electric Telegraph Company, 104.—Ditto (Rendel, J. M.), xi. 156.

Germany, &c. (Siemens, C. W.), xi. 362, 377.

History, theory, and practice. "The electric telegraph; its history, theory, and practical applications." By C. C. Adley, xi. 299.—Various means of telegraphing suggested and employed prior to introduction of electric telegraphs, 300.—Semaphore telegraph between London and Dover, and to Portsmouth, 301.—Chronological table of electrostatic telegraphs, 303.—Ditto of electrodynamic

ELECTRIC TELEGRAPHS.

telegraphs, 303.—Classified list of electric telegraph patents, 308.—Theoretic principles, 309.—Alarums, 311.—Connection of instruments, 311.—Triangular system of duplicates, 312.—Galvanometer, or detector, 312.—Resistance coils, 312.—Materials employed, 313.—Coils, 313.—Needles, 313.—Alarums, or bells, 314.—Telegraph batteries, 314.—Suspension and insulation of wires, 314.—Insulators, 315.—Screw piles for electric telegraph posts, &c., 317.—Gutta percha, and its value, 317.—Remarkable deranging causes, and investigations as to their origin, 318.—Lightning and lightning conductors, 318.—Demagnetization of needles, 319.—Action of needles during the 'aurora borealis', 319.—Periodic disturbances of the magnetic needle, 319.—Moveable studs and coils, 320.—Investigation of the origin of the periodic and other disaffections of the magnetic needle, 320.—Electric state of atmosphere, 320.—Magnetic storms, 322.—Earth currents, 323.—Thermo-electric currents, 323.—Caloric, 323.—Remarkable accidents to the electric telegraph, 324.—Laws which govern its action, 324.—Theory of the earth's circuit, 326.—Practical applications, 326.—Extent of lines of telegraph in operation, 328.

Improvements in. "On the electric telegraph, and the principal improvements in its construction." By F. R. Window, xi. 329.—Earliest forms of telegraph, 330.—Experiments made at various times with a view of determining the possibility of transmitting intelligence by means of electricity, 331.—Statement of the dates of the invention of the electro-magnetic telegraph in this country, 332.—Theory of the deflection of magnetic needles, 334.—On batteries, 337.—Earlier kinds, 337.—Modification by Brett and Little in 1846, 338.—Alarums rung by magneto-electricity, 339.—Mr. Wheatstone's instrument for ditto, 339.—Mr. Henley's ditto, ditto, 340.—Mr. Wheatstone's mo-

ELECTRIC TELEGRAPHS.

thod of adapting this principle to ring bells for signals, 340.—On wires, 342.—Means of insulation, 342.—Stretching posts and winding apparatus, 342.—Mr. Poole's stretcher, 348.—Mr. E. Clark's metallic-capped insulator, 348.—Gutta percha as an insulator, 344.—Submarine cable between Dover and Calais, 344.—System of insulation for towns, 345.—Professor Morse's experiments as to conducting powers of wires, 345.—Professor Draper's remarks upon ditto, 347.—On instruments, 348.—Mr. Alexander's instrument, 349.—Messrs. Wheatstone and Cooke's five-needle instrument, 349.—Ditto two-needle instrument, 350.—Messrs. Brett and Little's modification, 351.—Mr. Dering's instrument, 352.—Mr. Allan's combination of many magnets upon the same axis, 352.—Manner of action of rotary, step-by-step, indicating telegraphs, 353.—Mr. Highton's telegraph, on which the symbols are shown without any step-by-step movement, 355.—Instruments in which the signals sent are registered by the instruments themselves, 355.—Mr. Brett's instrument for obtaining reciprocal motion, 356.—Instruments relying solely for their effect upon chemical decomposition, 358.—Mr. Bain's application of this principle for telegraphic signals, 358.—Mr. Bakewell's arrangement for the purpose of copying writing, 360.

Discussion.—Adley, C. C., 361, 370.—Airy, Prof., 366.—Bakewell, F. C., 381.—Bidder, G. P., 373, 377.—Brett, J. W., 370, 378.—Brunel, I. K., 376.—Clark, E., 369, 373.—Clark, L., 378.—Doull, A., 377.—Glaisher, J., 382.—Gordon, A., 383.—Manby, C., 379.—Reid, W., 379.—Ricardo, J. L., 376.—Roberts, Lieut. J., 372.—Siemens, C. W., 362, 373, 377.—Statham, T. H., 378.—Walker, C. V., 377.—Walker, J., 377.—Whishaw, F., 371, 375.—Window, F. R., 361.

Importance of, in promoting the economy of railway working (Gregory, C. H.), xi. 465.—Extension of, on the continent

ELECTRO-MAGNETISM.

and in the colonies (Annual Report), xiv. 100.—Length laid down in Great Britain, its cost, and value to railway companies (Stephenson, R.), xv. 144.

India (Annual Report), xvi. 89.

London and North-Western railway, effect of, in working the, during the Great Exhibition (Huiah, Capt. M.), xi. 447.

United States, extract from the Report on the New York Industrial Exhibition, by Mr. Whitworth on, xi. 384.

Vide also TELEGRAPH CABLES.

Electric Telegraphs, submarine, (Window, F. R.), xvi. 188. *Vide also* TELEGRAPH CABLES.

Electro-deposition of zinc and other metals, for the preservation of iron (Pellatt, F.), ii. (1843) 167.

ELECTRO-MAGNETISM.

"On electro-magnetism as a motive power." By R. Hunt, xvi. 386.—Phenomena exhibited in electro-magnetic actions, 386.—Electro-magnet for developing the lifting power generated by the circulation of an electric current around it, 387.—Dal Negro's engine, 388.—Dr. Schulthess's engine, 389.—Professor Botto's engine, 389.—Jacobi's experiments and engine, 389.—Davenport's rotary engine, and Davidson's electro-magnetic locomotive, 390.—Professor Page's engine, 391.—Talbot's engine, 391.—Hjorth's engine, 391.—Causes which have led to the abandonment of the idea of employing electricity as a motive power, 392.—Attractive powers of magnets at slightly-varying distances, 393.—Tables showing the force of the current in an electro-magnet, and attractive force of the magnet, 395.—Production of the power, electro-magnetism, 396.—Evidence of Jacobi as to arrangements for generating (developing) electrical force in the form of a current, 396.—Mechanical force the result of change of form in matter, 397.—Conditions under which heat is employed as a motive power, 397.—Mean average result of the currents produced by several forms of battery power, 398.

ELECTRO-PLATING.

Discussion.—Allan, T., 416.—Bidder, G. P., 413.—Cowper, C., 405.—Gravatt, W., 419.—Grove, W. R., 402.—Highton, E., 420.—Hunt, R., 401, 414.—Petrie, —, 412.—Smee, W. A., 411.—Stephenson, R., 420.—Thomson, Prof. W., 400.—Tyndall, Prof., 404.

Electro-plating, vi. 355.

ELLICOMBE, R. R. [Election, xii. 109.]

ELLIOT, G. [Election, xv. 281.]

ELLIOT, L. [Election, x. 57.]

ELLIOT, W.

Dredging machines. "Description of a steam dredging engine used upon the Caledonian canal," ii. (1842) 149.

ELLIOTT, —.

Abattoirs, objections urged by the butcher's trade against the general establishment of, in this country, viii. 79.

ELLIOTT, J. [Telford medal, vii. 3; election, 184; resignation, xv. 85.]

Sea defences. "Account of the Dymchurch wall, which forms the sea defences of Romney Marsh," vi. 466.

— and SMITH, R.

Coasts, &c. Excavations at Lyme Castle (O'Brien, Capt.), xi. 211.

ELLIS, G. [Walker premium, ii. (1843) 7; decease, xvii. 107.]

Dredging machines. "Description of a machine called a floating clough," i. (1839) 48.

Viaducts. Drawings of the Calder viaduct made by him (Macneill, Sir J.), ii. (1842) 191.

Elstree reservoir, ii. (1842) 164.

EMBANKMENTS.

Formation of. "On the formation of embankments, and the filling-in behind retaining walls." By J. B. Hartley, i. (1841) 143.—The present mode described, 143.—Proposed modification of, by the adoption of footings and a different system of filling-in, 144.—Practised on the Manchester and Bolton railway, 145.—Method of filling-in behind retaining walls as now practised, 145.—Failure of a wall at Hunt's-bank, Manchester, 145.—Mode recommended, and practised

ENGLISH.

in the filling-in 'behind a wall at Jackson's dam, near the Brunswick graving docks, Liverpool, 145.

Reservoir. "On the formation of embankments for reservoirs to retain water." By R. Thom, ii. (1843) 191.—Proper slope for, 191.—Action of waves upon, 191.—Method of construction, 191.—Vermis, puddle for, 191.—Puddle trenches not approved of, 191.—Ditto not used at the reservoirs at Greenock, Paisley, &c., 191.

Vide also RAILWAY CUTTINGS AND EMBANKMENTS, RECLAIMING LAND FROM THE SEA, RESERVOIRS, and SEA DEFENCES.

Embankments of the river Thames, xv. 200. *Vide also* RIVER THAMES.

Embankments and cuttings, instrument for setting out the width of, (Carr, H.), i. (1839) 52.

Engine-counters, Richmond's, vii. 71.—Boulton and Watt's, 73.

Engineer appointments, Public Works Department, India, xix. 148.

Engineering works, summary of the most important, constructed in Great Britain during the latter half of the last century, v. 24.—In Holland, vi. 112.—Ancient and modern, contrasted, xiv. 209.

Engineers, mechanical and civil, connection between, and their dependence upon each other, vii. 32.—The mechanical engineer the first to apply the great powers of nature, 33.—Establishment of a separate class, called 'Civil Engineers,' 34.

Engine houses, &c., mode of securing the foundations of, ii. (1843) 138.

ENGINES. *Vide* AIR ENGINES, COMBINED VAPOUR ENGINE, HYDRAULIC ENGINES, LOCOMOTIVE ENGINES, MARINE ENGINES, and STEAM ENGINES.

ENGLAND, G.

Screw jack. "An universal screw jack," i. (1840) 60.

ENGLAND, J. [Election, vii. 184.]

ENGLAND, J., Jun. [Election, xvi. 226.]

ENGLISH, H. [Resignation, x. 72.]

ENYS.

- ENYS, J. S.** [Election, i. (1839) 49.]
 Mines, temperature of, ii. (1843) 141, 142.
 Steam engines. Economy of working steam expansively in crank engines, i. (1839) 45.
 — "Observations on the efficiency, or gross power of steam exerted on the piston in relation to the reported duty of steam engines in Cornwall, at different periods," i. (1840) 1.—Duty and effect of steam engines, 15.—Best speed to work an engine, 17.
 — "On the stamping engines in Cornwall," i. (1840) 83.
 — Comparative measure of the power of engines adopted in Cornwall, x. 313.
EPSTEIN, L. [Election, xvi. 226.]
 Equatorial instrument by Huddart, ii. (1842) 57.
ERICSSON, Captain.
 Screw propeller on board the 'Princeton' steam-frigate (Braithwaite, F.), iii. 83.—Ditto on board the 'Robert Stockton,' 83.
 Water-meters. His rotary fluid and reciprocating fluid-meter (Chadwick, D.), xiii. 426.
Vide also AIR ENGINES.
ERRINGTON, J. E. [Member of Council, ix. 91; x. 60; xi. 84; xii. 112; xiii. 123; xiv. 97; xv. 76; xvi. 88; xvii. 70; xviii. 164; xix. 132; xx. 108.]
 Cofferdam at Great Grimaby, cost of, ix. 12.
 Girders, strength of cast-iron, xiii. 474.
 Masonry. Mixture of ashlar and rubble, and definition of latter work, x. 238.
 Permanent way, ix. 407.—Duration of stone blocks, timber sleepers, and rails, xi. 291.—Cost of maintenance of way on the London and North-Western railway, 292.—Scotch larch sleepers, xii. 241.—Permanent way, particularly as to Mr. Adams' open bracket chairs, the fish-joint, Mr. De Bergue's cast-iron plate sleepers, and as to the reversing of the double-headed rail, xvi. 277.—Advantages of the double-headed rail, xix. 237.
 Public works, undesirability of central-

EVANS.

- ized authorities exercising an undue influence in the matter of, xiii. 118.
 Railway breaks, Newall's, xvii. 171.
 Railway cuttings, open, in place of tunnels, xiii. 477.
 Roofs. Iron roof over the railway station, Lime-street, Liverpool, ix. 213.
 Escapement of chronometers, watches, &c., vi. 224.
ESTRIDGE, Captain J., B.E. [Election, ix. 57.]
 Ether engine. Performances of the screw steam ship 'Sahel,' fitted with Du Trembley's combined vapour engine, and of the sister ship 'Oasis,' fitted with steam engines worked expansively, and provided with partial surface condensation (Jameson, J. W.), xviii. 233.
ETTY, T. B. [Election, x. 293.]
EVANS, —.
 Fire-arms, Collier's and Coolidge's flint lock revolving chambered-breech, xi. 62.—Employment of machinery in Government Small Arms Manufactory at Enfield, 62.
EVANS, F. J. [Election, i. (1840) 31.]
 Gas, comparative quantities of, made by clay and by iron retorts, xvi. 318.—Formation of the bisulphuret of carbon, when gas is produced at a high heat, 319.—Leakage through mains, 319.
EVANS, Captain G., B.N. [Election, iii. 248.]
EVANS, J. [Election, xii. 272.]
 Drainage of towns. Working of the pipe-drain system at Salford, xii. 81.
EVANS, J. [Election, xix. 130.]
 Drainage of land. Effect of land drainage upon the streams, xx. 227.
 Drainage of towns. Sewage and its utilization, xx. 237.
 Rain-gauge used at Mr. Dickinson's mill at Hemel Hempstead, xiv. 86.
 River Bourne at Croydon, and similar Bourne in Hertfordshire, xx. 227.
 Water supply. Amount of rainfall and of percolation through the soil in a chalk district of Hertfordshire, xx. 219.—Tables of rainfall and percolation through Dalton's gauges, filled with

EVANS.

surface soil and chalk, at Nash Mills, Hertfordshire, from October, 1833, to December, 1860, 222.—Causes which affected percolation, 225.—Improved form of Dalton's gauge, and the mode of making the gaugings, 225.—Quantity of water flowing off by streams and rivers, 226.—Laws relating to the uses and rights of ownership of water flowing above ground, 251.

EVANS, T. [Election, i. (1838) 9.]

Evaporation, spontaneous, and rainfall, at Melbourne, Geelong, Yan-Yean, and Ballarat, during the years 1855, 1856, and 1857, xviii. 382, *et seq.*

—, and rainfall, remarks as to, in the course of the discussion on the river Wandle, xx. 214, *et seq.*

EVILL, W., Jun. [Election, i. (1841) 97; Walker premium, iv. 4.]

Railway stations. "Description of the iron shed at the London terminus of the Eastern Counties railway," iii. 288.

EWART, P. [Memoir, ii. (1843) 25.]

Automaton balance, Mr. Ewart consulted as to the construction of the, (Ootton, W.), ii. (1843) 124.

EXALL, W. [Election, x. 57.]

Engines, best form of fire for small portable, xvi. 84.

Machinery, band saw, (Molesworth, G. L.), xvii. 25.

Excavator, American, for dredging (Hyde, J. B.), iv. 399.—Account of its use and application on the Eastern Counties railway, 399.

Exhausting process used in Kyanizing, wetting bank-note paper, preserving meat, and cleansing wool, ii. (1842) 82.

EXHIBITION in 1851.

"On the construction of the building for the Exhibition of the works of industry of all nations in 1851." By M. D. Wyatt, x. 127.—Requisites of the building, 127.—Principles of the proposed plans, 129.—Description of the site, 130.—Requisites finally assumed, 130.—Design of the present building, 132.—Area covered,

EXPANSION.

133.—General features of the design, 133.—Drainage, 133.—Flooring, 134.—Foundation and base-plates, 134.—Columns and connecting-pieces, 135.—Various heights of portions of the building, 136.—Galleries, 138.—Face-work, 140.—Sashes, 142.—Exits, 143.—Roof-trusses and girders, 143.—Experiments tried on ditto, 144.—Extra-strong trusses, 146.—Semi-circular ribs, 146.—Transept roofing, 149.—Connections of the roof-trusses, &c., 150.—Provisions for stiffening the building, 150.—Paxton roofing, 151.—Ditto, over the transept, 154.—Ventilation, 154.—Canvas covering, 155.—Water supply, 156.—Execution of the works, 156.—Modifications of the original design, 157.—The proving of the girders, 157.—Setting out and progress of the work, 159.—Glazing-machines, 160.—Painting-machine, 161.—Mode of raising the transept ribs, 162.—Conclusion, 164.

Discussion.—Airy, Prof., 177, 188.—Cubitt, Sir W., 191.—Doull, A., 185.—Fox, Sir C., 188.—Freeman, J., 180.—Gregory, C. H., 191.—Heppel, J. M., 174.—Pasley, Lieut.-Gen. Sir O. W., 180.—Paxton, Sir J., 172.—Pellatt, A., 190.—Robertson, A. J., 180.—Russell, J. S., 170.—Turner, R., 166, 186.—Vignoles, C., 165.—Wild, C. H., 172.—Wyatt, M. D., 165, 190.

— (Annual Report) xi. 85; (Cubitt, Sir W.), 147; (Rendel, J. M.), 149.

— effect of electric telegraph in working London and North Western railway, during the, (Huish, Capt. M.), xi. 447.

Exhibition of all Nations at Dublin, xii. 243; xiii. 124.

— Paris, International, of 1855, xiv. 102; xv. 77.

Expansion gear, &c., Bodmer's variable, iv. 373.

Expansion of arches (Rennie, G.), i. (1840) 4.

— of steam, on the laws of the, (Tate, T.), vi. 343.

Expansive action of steam (Heppel, J. M.), vi. 316.

EXPERIMENTS.

Experiments to determine the force necessary to punch holes through plates of wrought-iron and copper (Colthurst, J.), i. (1841) 60.—Rule and formula reduced from the foregoing, 61.
Explosions of gas in coal mines, *Vide* COAL MINES; of locomotive boilers, *Vide* Lo-

EXPROPRIATION.

COMOTIVE BOILERS; of steam boilers
Vide STEAM BOILERS.
Exposition Universelle des Produits de l'Industrie de toutes les Nations, à Paris, xiv. 102; xv. 77.
Expropriation in Holland, iii. 175, 176.

F.

FACTORY.

Factory, woollen, ii. (1843) 125.

FAIRBAIRN, P.

Railways, application of stationary engine power to, i. (1841) 148.

FAIRBAIRN, T. [Election, iv. 186; resignation, xi. 93.]

FAIRBAIRN, W. [Telford medal, iv. 3.]

Arches, elliptical cast-iron, experiments upon, xviii. 356.

Bridges. "On tubular girder bridges," ix. 233.—Reasons for not taking into account the continuity of the girders, 276.

—, iron, strength of, xiii. 470.

Caisson, sliding. "Description of the sliding caisson at Keyham dockyard," xiii. 444.—Remarks, 457, 459.

Fire-proof buildings. Account of the woollen factory near Izmet (Turkey), ii. (1843) 125.

— "On some defects in the principle and construction of fire-proof buildings," vi. 213.

— Principles on which he proposed to build fire-proof warehouses, and objections to such structures (Braidwood, J.), viii. 144.

Girders, cast-iron, strengths of the, at the Gravesend Terrace pier, iv. 247.

Hydraulic engines. Water pressure engine, erected by him (Taylor, J.), ii. (1843) 144.

Iron ores. "Experimental researches into the properties of the iron ores of Samakoff, in Turkey, and of the hæmatite ores of Cumberland, with a view to determine the best means for reducing them into the cast and malleable states; and on the relative strength and other properties of cast-iron from the Turkish and other hæmatite ores," iii. 225.

Iron, wrought and cast. Method of calculating the power to resist impact (Farey, J.), ii. (1843) 132.

FARADAY.

Iron. "Experiments on the strength of cast-iron smelted with purified coke," xii. 360.—Remarks, 375.—Calvert's process of purifying coke, 375.—Manufacture of iron, 377.

— Preparation of cast-iron, xviii. 356.

Locomotive engines, manufacture of, by railway companies, instead of by private manufacturers, xi. 475.—Tank locomotive engine, used on the Oldham incline, xv. 371.

Materials, strength of. Deterioration in strength of bodies subjected to intermittent strain, xiii. 463.

Railway, atmospheric, iv. 279.

Railway axles, Handcock's improved form of, ii. (1843) 167.—Causes of the fracture of, xiii. 469.

Railway breaks. "On the efficiency of various kinds of railway breaks, with experimental researches on their retarding powers," xix. 490.

Smoke, prevention of. Quantity of air necessary for the perfect combustion of the gases in furnaces, and means of avoiding smoke, xiii. 412.

Turbines, viii. 60, 62, 63.

Water-wheels, construction of, (Rennie, G.), ii. (1843) 63, 64.—System of constructing, and velocity of, iii. 67.

— "On water-wheels with ventilated buckets," viii. 45.—Remarks, 60, 62, 63.

Water-works, Melbourne Gravitation, xviii. 400.

Weirs. Introduction of oblique weirs, and their advantages, v. 352.

FAIRBANK, J. F. [Election, xvi. 226.]

Gas, merits of iron retorts for making, xvi. 322.

FALSHAW, J. [Election, iii. 475.]

FARADAY, Dr. [Election, i. (1838) 51.]

Bude light, ii. (1843) 189.

Carbonic acid, opinion of Dr. Marshall Hall, on the poisonous action of, ii. (1843) 190, 191.

FARADAY.

Electric telegraph. Cause of the difference in the velocity of the electric currents in suspended and underground or submarine wires, xvi. 220.—Results of voltaic and of magnetic induction, on the wire envelope, 222.

Fuels. Resin fuel, i. (1839) 35.—Process of combustion of fuel, xi. 403.

Heated air, use of, as a motive power, xii. 348.

Iron. Composition of pig-iron, ii. (1842) 61.—Clay's process of making iron, ii. (1843) 86.

Lamp-burners, suggestion of plans for ventilating, ii. (1843) 184.—On the ventilation of, 188.

Lighthouse lamps, ii. (1843) 190.

— "On the ventilation of light-house lamps; the points necessary to be observed, and the manner in which these have been, or may be obtained," ii. (1843) 206.

Metals, corrosion of, i. (1839) 34.

Respiration. Quotation from M. Edwards, "De l'influence des agens physiques sur la vie," ii. (1843), 190.

Steam boilers. Diaphragm steam generator, xi. 398.—Boiler explosions, 398.

Stone, artificial, manufacture of, with a silica base, vii. 60, 61.—Difference between the composition and the manipulation of terra cotta and this artificial stone, 64.

Water. Chemical changes which water undergoes in passing through chalk, ix. 160.

FARADAY, J.

Lamp-burners. "Description of a mode of obtaining the perfect ventilation of lamp-burners," ii. (1843) 184.

Faram's railway switch, iii. 127.

FARREY, J. [Memoir, xi. 100.]

Air, resistance of. Robins' experiments for determining the resistance of air to cannon balls, v. 298.—Hutton's ditto to bodies of different forms, and at different velocities, 298.—Edgeworth's comparative experiments, 295.—Beaufoy's ditto, with table of results, 295.—Computations made by Beaufoy from his experiments, 297.

FAREY.

Animal power, i. (1839) 37.

— "On Mr. Smeaton's estimate of animal power, extracted from his MS. papers," i. (1839) 50.

Arithmetical instruments. Present of Sir S. Morland's scarce work on "Arithmetick Instruments," 1673, iii. 70.

Boring tools. 'Miser,' ii. (1843) 59.

Brickmaking, machinery for, ii. (1843) 147.

Bricks, use of cavities in, ii. (1843) 148.

Bridges. Failure of the Yarmouth suspension bridge, iv. 346.—Vertical sides of tubular girder bridges, ix. 271.—Loss by rivet holes to be allowed for in computing the sectional area of the metal, 272.

Chronometers. Principles of mechanical action involved in the construction and operation of marine chronometers, vi. 239.—Proper conditions of the balance spring, 239.—Nature of the progressive motion of the balance, 241.—Isochronal vibrations, 241.—Mode of trial adopted for the adjustment of marine chronometers, 242.—Effect of the friction of the balance on the isochronism of the spring, 243.—Conditions under which a spring would produce isochronal vibrations of the balance, 243.—Revival of tapering springs, 244.—Old watches used before the invention of the balance spring, 245.—Worm-wheel and worm used for setting up the main spring in watches, 245.—The objections to allowing the case of a chronometer to be opened at sea, 245.—Progress of the art of horology, 246.—Effects of the reward offered by Parliament for the discovery of practical means of determining the longitude at sea, 246.—Use of cedar-wood for chronometer cases, 248.—On the reduction of friction in chronometers, 248.—Mr. Watkins' invention for diminishing friction in chronometers, 249, 250.—On Mr. Hardy's ditto, 250.

Coal-mines, diminution in the number of accidents in, viii. 136.

Coasts, alterations in. Power of the waves and littoral currents in forming

FAREY

- accumulations of transportable material on the beach, viii. 204.
- Cranes. Invention of the moveable jib-crane, iv. 345.—Limit to which the boom should be extended, 345.—Application of hydraulic machinery to cranes, ix. 386.
- Drainage. Extracts from Smeaton's unpublished MSS., iv. 205.
- Engine-counters, vii. 73.
- Fire-proof buildings. Construction of Messrs. J. and J. L. Gray's cotton mill at Manchester, and falling of a portion thereof, vi. 217.—Cast-iron beams for fire-proof buildings, 218.—Construction of fire-proof buildings, viii. 149.—Ditto, cotton mills, 161.
- Friction, ii. (1843) 78.
- Fuel, use of peat, i. (1839) 80.
- Furnaces, blast, quantity of air entering, i. (1840) 67.
- Gas-meters, iv. 219, 222.
- Gas pipes, manufacture of, iv. 220.
- Horse-power, method of calculating, iii. 283.—Estimate of the standard of the power of a horse, x. 315.
- Indicator, Moseley's constant, ii. (1842) 107, 118.—Penn's, 135.—Watt's, x. 316.
- Iron. Change of cast-iron into plumbago, ii. (1842) 153.—Experiments on, at the Milton iron works, and on making, ii. (1843) 129.—On testing the strength of, 132.—Proportion between the bearing and breaking weights, in different situations, where iron is used, iv. 347.—Change suffered by cast-iron when in contact with gun-metal, and under the influence of high-pressure steam, vii. 157.—Method of rolling bars at once into the required form, for suspension bridges, and other similar purposes, instead of welding on the heads, viii. 275.
- Lighthouses, Maplin Sand and Port Fleetwood, ii. (1842) 152; vii. 156.
- Locks and keys. Bramah's locks, ix. 381.—Machines used for their manufacture, 382.—Barron's lock, 383.—Chubb's, 384.—Security afforded by the detector in ditto, 384.—Improbability of one of Chubb's locks being picked,

FAREY.

- 339.—Means of securing iron chests or safes, 342.
- Machines. Amount of friction of the moving parts, in large and powerful machines, vi. 248.—On the application of oil for diminishing, 249.—Consequences resulting from the use of rape oil to the machinery of a cotton mill at Glasgow, 249.—On the contrivance of a small machine, for comparative trials of the qualities of different kinds of oil for reducing friction, 249.
- Metals, porosity of, iii. 304.—Action of brine, sea and fresh water, in corroding, iv. 331.
- Permanent way. Machine for seating and fastening chairs on sleepers, iv. 58.
- Prosser's system of producing buttons, small tiles, and slabs for painting, ii. (1843) 147.
- Pump-valves, iii. 94.
- Railway, atmospheric, iii. 277.
- Rivers, flow of water in, under certain conditions, v. 358.
- Screw-propellers, iii. 77.
- Steam boilers, various plans for preventing the incrustation of, v. 213.
- Steam engines, strength of iron work used in, iv. 346.—Condensing, used on the old Bolton railway, v. 157.—Indicator diagrams taken from the engines at the Minories' station on the London and Blackwall railway, 158.—Employment of high-pressure steam, working expansively in marine engines, viii. 308.—Watt's indicator, x. 316.—Boulton and Watt calculated the actual power of their engines, by observing the speed of the piston, and comparing it with the average pressure of steam upon it, 316.
- Steam navigation, &c. Proportions of steam vessels, and their machinery for ocean steam navigation, vi. 489.
- Stone, artificial, properties of the, made with a silica base, and its comparison with terra-cotta, vii. 63.
- Street cleansing, advantages of mechanical, vi. 463.
- Turbines, ii. (1842) 102.
- Water-wheels, ii. (1843) 63.

FASCINE EMBANKMENT.

- Wells, ii. (1843) 58.
 Wind, Smeaton's table of the force, velocity, and work performed by, v. 289, 290.—Dr. Lind's wind-gauge, 290.—Effects of different winds on Smeaton's oil windmill at Austhorpe, 291.—Table by Smeaton of the velocity of the wind under different circumstances, 292.—Comparison of the opinions of Dalrymple and Smeaton on the velocity of, 293.
 Wire rope, peculiarities of the, used on the London and Blackwall railway, v. 155.
 Fascine embankment, mode of constructing, and dimensions of the, for dividing off the Alkmaar lake, vi. 90.
 ——— works, description of different kinds of, vi. 101.
 Fascines and sea-weed, used for sea-walls, ii. (1842) 128.
 Fastenings for railway chairs, ii. (1843) 85.
 Fatigue, and consequent fracture, of metals (Braithwaite, F.), xiii. 463.
 Fauvel's process of using water pressure in boring wells, reference to, xx. 298.
 Fay's continuous break, report of Colonel Yolland relative to, ix. 491.
 Feathering paddles, by J. Oldham, used on board the 'Aaron Manby,' iv. 184.
 Felspar, used as porcelain glaze, ii. (1843) 154.
FENTON, J.
 Drainage of towns. Works for purifying the sewage water at Croydon, xx. 235.
 River Wandle. Springs of the Bourne, the source of the river Wandle, and the quantity of water rising from each, xx. 217.
FENTON, Jas. [Election, viii. 206.]
 Safety valves. "Description of an improved form of safety valve, for steam boilers," xv. 33.
FERRIÈRE, A. D. DE. [Election, iii. 173.]
FERRIES.
 Devonport. "On the floating bridge across the Hamoaze from Devonport to Torpoint." By J. M. Rendel, i. (1838) 21.
 Discussion.—Rendel, J. M., 24.—Vignoles, C., 23.

FIELD.

- Kaffre Azzayat. "Account of the steam ferry over the river Nile, at Kaffre Azzayat." By T. Sopwith, xvii. 53.—Description of the first-made African railway, 53.—Singular aspect of the railway works, 53.—Avidity of the population for railway transit, 55.—World-wide character of this extension of the railway system, 55.—Scenery on the railway journey from Alexandria to Kaffre Lais, 55.—Dimensions and mode of construction of the ferry, 56.—Facility with which the passage is effected, 57.—Details of the jetties at Kaffre Lais and Kaffre Azzayat, 58.—Further details and dimensions of the ferry, 59.—Means by which the vertical movement of the middle platform is effected, 59.—Adaptation of chains as a guide and means of applying motive power, 61.
 Discussion.—Greaves, C., 63.—Hemans, G. W., 63.—Moorsom, Capt. W. S., 64.—Rennie, Sir J., 64.—Sopwith, T., 68.—Stephenson, R., 64.
 Portsmouth (Greaves, C.), xx. 386.
Vide also RAILWAY FERRIES.
 Ferry boats, American, xx. 388.
FIELD, C. W.
 Telegraph cables. Construction of the Atlantic telegraph cable, xvii. 302.—Conducting power of a submarine cable, 326.—Proceedings of the Atlantic Telegraph Company, 335.—Form and specific gravity of the cable, 335.—Report from the engineers engaged in the undertaking in 1857, 336.—Communication signed by every commanding officer attached to the telegraph squadron in 1857, 337.—Relative merits of light and heavy cables; the Black Sea cable, and that belonging to the Mediterranean extension company, 338.—Atlantic cable not tested under water when completed, 339.
 Waves, height of, in the North Atlantic, xvii. 326.—In the Atlantic Ocean, 338.—Height and velocity of, off the Cape of Good Hope, 339.—Ditto, Cape Horn, 339.

FIELD.

FIELD, J. [Vice-President, i. (1837) 15; (1838) 20; (1839) 27; (1840) 36; (1841) 52; ii. (1842) 51; (1843) 67; iii. 66; iv. 62; v. 142; vi. 46; President, vii. 56; viii. 44.]

Address, on taking the chair for the first time after his election as President, vii. 32.—Connection subsisting between the mechanical and the civil engineer, and their dependence upon each other, 32.—The mechanical engineer the first to apply the great powers of nature, 33.—As public works, principally for facilitating communication, increased, a separate class of engineers, called 'Civil Engineers,' was established, 34.—Effects of the progressive improvement in the manufacture of iron, 34.—Application of the steam engine to navigation, 35.—Ship-building in iron, 35, 39.—Supply of towns with water and gas, 36.—Gradual improvement in the tools and apparatus for constructing machinery, 36.—Progress of the marine engine and steam navigation, 38.—High speed attained by the introduction of the tubular boiler, 40.—Reduction in the consumption of fuel, 42.—Introduction of the screw propeller, 42.

— to the annual general meeting, January, 1849, viii. 28.—Notice of the career of the late Mr. George Stephenson, 29.—Condition of the locomotive engine when the Manchester and Liverpool railway was projected, 30.—Results of the introduction of the multitubular boiler and of the blast-pipe, 31.

— on vacating the chair, ix. 118.

Air engines, Stirling's, iv. 357, 360.

Artillery. Cannons cast at the Carron foundry, ii. (1843) 133.

Boats, passage, for inland navigation, i. (1840) 29.

Boilers. Comparative proportions and effect of a locomotive boiler, and of a tubular marine boiler, xii. 416.

Bridges. Experiments for determining the dimensions of the pin, the head, and the body of the link, for the Menai bridge, viii. 278.

FIELD.

Civil and mechanical engineers. Connection subsisting between the mechanical and the civil engineer, and their dependence upon each other, vii. 32.—The mechanical engineer the first to apply the great powers of nature, 33.—As public works, principally for facilitating communication, increased, a separate class of engineers, called 'Civil Engineers,' was established, 34.

Engine-counters, vii. 73.

Fire-proof dwelling houses and warehouses, especially in reference to the question of insurance, viii. 160.

Fuel, combustion of different kinds of, i. (1840) 67.—Reduction in the consumption of, vii. 42.

Governors. Messrs. Siemens' chronometric governor, v. 263.—Other governors, 263.—Watt's centrifugal governor, 264.

Horse power, ii. (1843) 114.

Iron, effect of re-melting, ii. (1843) 130, 133.—Effects of the progressive improvement in the manufacture of, vii. 34.

Locomotive engines. Condition of the locomotive engine when the Manchester and Liverpool railway was projected, viii. 30.—Results of the introduction of the multitubular boiler and of the blast-pipe, 31.

Machinery, gradual improvement in the tools and apparatus for constructing, vii. 36.

Manufactories, advantages of constructing, on one floor, ii. (1842) 145.

Marine engines, employment of high-pressure steam, worked expansively, in, viii. 308.—Boilers for, 309.

Naval construction, &c. Durability of iron ships, ii. (1843) 178, 179.—Improvements in naval architecture, made by the late Sir Samuel Bentham, iv. 178.—Ship-building in iron, vii. 35, 39.

Portrait of, added to collection of portraits of past presidents (Annual Report), xiv. 107.

Railway axles, Handcock's, ii. (1843) 167.

Rivers. System of spurs on the Moselle, vii. 244.

Screws, Uniformity of thread, i. (1841) 160.

FIELD.

- Smoke, different systems for consuming, xiii. 410, 411.
- Steam boilers, explosion of, i. (1838) 42, 43; (1841) 114.
- Steam engines, duty and effect of, i. (1840) 16.—Modes of economising heat and steam, 80.—Friction of steam engines, ii. (1843) 70.—Observations on defective workmanship in steam engines, iv. 296.—The power of a steam engine should be estimated by the diameter, or area of the piston, the effective pressure on the piston, and the speed of the piston, x. 312.—Actual and nominal horse power of steam engines, 315.
- Steam navigation, &c. Proportion of the power of the engines to the tonnage in steam vessels, i. (1841) 70.—Velocities of steam ships, 71.—Use of the screw propeller in auxiliary steam vessels, vi. 291.—Relative power of paddle-wheels and a screw, 292, 297.—Application of the steam engine to navigation, vii. 35.—Progress of the marine engine and steam navigation, 38.—High speed attained by the introduction of the tubular boiler, 40.—Introduction of the screw propeller, 42.
- Stephenson, G., notice of the career of, viii. 29.
- Timber. Causes of the worm, (*Teredo navalis*), being destructive in fresh water, vi. 54.
- Towns, supply of, with water and gas, vii. 36.
- FIELD, J., Jun. [Election, xvi. 309.]
- FIELD, T. [Election, xx. 258.]
- Filter, natural, sandy peninsula opposite Dalmarnock, recommended to be used as a, by James Watt, ii. (1843) 136.
- Filtering sugar by Howard's process, ii. (1843) 138.
- Filters. Construction of the filter recommended by Telford, ii. (1843) 137.—Slow filtration necessary for the Clyde water, 137.—Precipitation accelerated by pipe-clay, &c., 137.—Proper arrangement of filtering beds, 137.—Impurities should be arrested near the planes of ingress, 137.—Duration of filtering

FIRE ARMS.

- medium, 137.—Slow filtration without pressure, recommended, 138.—Rate of filtration must depend on the quality, as well as the quantity of matter in suspension, 138.—Extensive settling reservoirs necessary for good filtering, 138.
- FIRE ARMS.
- Enfield rifle (Strode, W.), xix. 376; (Hay, Gen.), 401.
- Experiments upon gun-barrels, ii. (1843) 107.
- Manufacture of. "On the application of machinery to the manufacture of rotating chambered-breech fire arms, and the peculiarities of those arms." By Col. S. Colt (U.S. America), xi. 30.—Ancient examples of repeating fire arms, 31.—Match-lock gun of fifteenth century, in Tower of London, 32.—Ditto, with revolving breech, at Musée d'Artillerie, Paris, 32.—Ditto, brought from India by Lord W. Bentinck, 32.—Pyrites wheel-lock musketoon in the Tower of London, 33.—Pistol of similar construction in the Rotunda, at Woolwich, 33.—Arm of seventeenth century, with pyrites lock and eight chambers, in the Hotel Cluny, at Paris, 33.—Spanish gun, of eighteenth century, with flint lock, in the Rotunda, at Woolwich, 34.—Gun with flint lock and breech with four chambers, to be rotated by hand, at Warwick Castle, 34.—Arm similar to ditto in the Tower of London, 35.—English gun, not more than a century old, having a breech with four chambers, to be rotated by hand, 35.—Brass model pistol, with six chambers, of time of Charles I., at the United Service Museum, London, 36.—Rotating chambered-breech gun, with flint lock, patented, in 1818, by E. H. Collier, U.S., 36.—Flint-lock chambered-breech fire-arm, patented by O. Coolidge, in 1819, 37.—Breech patented by H. Nock, in 1787, 37.—Application of fulminating powder for igniting charge in chamber of barrel, patented by Rev. Mr. Forsyth, in 1807, 37.—Rotating chambered-breech pistol, con-

FIRE ARRANGEMENTS.

- structed in 1835, by Col. Colt, 38.—Rifles and muskets on principle of ditto, 39.—Rifle made by Col. Colt, in 1836, to rotate and fire by continued action of lever, or by use of trigger, 40.—Alterations to prevent premature and simultaneous explosions of charges in different chambers, 40.—Use of Col. Colt's arms in Florida war in 1837, 42.—Ditto in Mexican campaign in 1847, 42.—Arms at present constructed by Col. Colt, 43.—Details of manufacture and machinery employed, 44.—Major-General Taylor's opinion as to use of these arms in Mexican war, 46.—Extract from New Quarterly Review for July, 1852, as to Col. Colt's repeating fire arms, 47.—Results of practice at Woolwich, from 13th to 21st October, 1851, 48.
- Discussion.—Adams, R., 56.—Adams, W. B., 64.—Belcher, Admiral Sir E., 54.—Chalmer, Col., 58.—Colt, Col., 51, 54, 59, 62.—Evans, —, 62.—Freeman, J., 56.—Glynn, J., 63.—Hastings, Com. Sir T., 53, 54, 58.—Hawthaw, J., 63.—Heppel, J. M., 64.—Hodge, P. R., 61, 62.—Lawrence, Hon. A., 52.—McNeill, Gen., 66.—May, C., 58, 63.—Miles, P., 58.—Pasley, Lieut.-Gen. Sir C. W., 55.—Rendel, J. M., 59.—Richards, A. B., 55, 57.—Riddell, Capt., 55, 51.—Russell, J. S., 63.—Walker, Hon. J. R., 64.
- Tube for placing detonating caps on the nipple of a rifle or a musket (Néron, M.), xiv. 189.
- Whitworth rifle (Whitworth, J.), xix. 400; (Hay, Gen.), 401.
- Fire arrangements at Liverpool, xii. 477.
- at Manchester, xii. 508.
- Fire-bars, best proportions of, for steam boilers, iii. 331.
- Fire-bricks, ii. (1843) 154. *Vide also* BRICK-MAKING, and BRICKS.
- Fire-brigade floating engine, Metropolitan, applicability of Ruthven's system of propulsion to, xiii. 377. *Vide also* FIRES, MEANS OF EXTINGUISHING.
- Fire-damp, in mines, vi. 162.
- , on the explosion of, which occurred

FIRE-PROOF BUILDINGS.

- in the Eaglesbush, or Eekyn colliery, near Neath, South Wales, on the 29th of March, 1848 (Richardson, J.), viii. 118. *Vide also* COAL MINES, explosion in.
- Fire engines, supplies of water for, (Braidwood, J.), iii. 310.—Depth engines will draw water from, 311.—Engines most approved in London, 319.—Application of manual power to, 319.—Best rate of working, 321.—Sometimes not properly supplied with hose, 325. *Vide also* FIRES, MEANS OF EXTINGUISHING.
- Fire-grate, Bodmer's, (Bodmer, J. G.), v. 362.
- Fire-place, domestic, means of preventing the nuisance of smoke from the, xiii. 405.
- FIRE-PROOF BUILDINGS.
- Construction of. "On some defects in the principle and construction of fire-proof buildings." By W. Fairbairn, vi. 213.—On the falling of a portion of Messrs. J. and J. L. Gray's cotton-mill, at Manchester, 213.—On the use and application of iron as a material for building, 214.—Description of the building, 214.—Calculation of the breaking-weight of the beams which had to support the upper floor, 215.—Comparison of the strength of the broken beam with the load it had to sustain, 215.—On the investigation of the causes of accidents, 217.
- Discussion.—Albano, B., 222.—Bidder, G. P., 220, 222.—Farey, J., 217.—Handyside, W., 221, 223.—Pasley, Lieut.-Gen. Sir C. W., 222.—Rennie, G., 222.—Rennie, Sir J., 224.—Stephenson, R., 219, 223.—Vignoles, C., 220, 223.
- "On fire-proof buildings." By J. Braidwood, viii. 141.—Effect which a fire has upon the materials of construction, especially upon iron, 142.—Specimens of cast and wrought iron fused at fires in large buildings, 142.—Loss of strength in cold-blast cast-iron due to increase of temperature, 142.—Want of safety in buildings constructed with wrought-iron tie, or tension-rods,

FIRE-PROOF BUILDINGS.

to take the lateral strain of the arches, and also in trusses to support the beams, 142.—Principles on which Mr. Fairbairn proposes to build fire-proof warehouses, 144.—Principal objections to such buildings, 145.—Construction which must be adopted to render large buildings fire-proof, 145.—Appendix; Illustration of the inability of cast-iron to resist the effects of fire, 146.

Discussion.—Barrett, J., 162.—Bateman, J. F., 159, 161.—Bidder, G. P., 157, 159.—Braidwood, J., 147, 153, 156, 157, 160, 162.—Chubb, J., 154.—Cottam, G., 148.—Dines, T., 153, 158.—Farey, J., 149, 161, 162.—Field, J., 160.—Godwin, G., 152.—Hoaking, Prof., 146, 148, 150.—Hodgkinson, E., 155, 158.—May, C., 159.—Moorsom, Capt. W. S., 156.—Pasley, Lieut.-Gen. Sir C. W., 162.—Piper, W., 151.—Rendel, J. M., 160.—Stephenson, R., 155, 159.—Thorold, W., 156.—Whishaw, F., 148.

Construction of. "On the construction of fire-proof buildings." By J. Barrett, xii. 245.—Iron-girder and brick-arch system, 246.—Fall of cotton-mill, at Oldham, in 1845, 247.—Objects sought to be accomplished by Barrett's system of fire-proof construction, 248.—Principle of ditto, 248.—Application of system to dwelling-houses and similar buildings, 251.—Family dwellings in Mile-End New Town, erected upon this principle, by the Metropolitan Association for Improving the Dwellings, &c., 253.—Application of system, with both girders and joists of cast-iron, 253.—Combination of wrought-iron boiler-plate girders and cast-iron joists, 254.—Application of wrought iron, exclusively, for both girders and joists, 253.—Floors on fire-proof principle, at the Royal Porcelain works, Worcester, 256.—Experiments as to transverse strength of the rolled-iron joists, 258.—Cost of fire-proof construction, 259.—Practical value of concrete in resisting the effects of intense heat, 259.—Desirableness of fire-proof construction,

FIRES.

261.—Appendix: Estimates of cost based on London prices, approximate cost of floors for dwelling-houses, 263.—Ditto, estimated cost of the floor of a mill, or factory, 264.

Discussion.—Barrett, J., 267, 268, 269, 271.—Braidwood, J., 266.—Edington, —, 268.—Hunt, H. A., 270.—I'Anson, —, 267.—Jackson, Lieut., 266.—May, C., 266.—Penrose, F. C., 268.—Rendel, J. M., 271.—Simpson, J., 269.

Woollen factory near Izmet (Turkey), (Fairbairn, W.), ii. (1843) 125.

Vide also FLAX MILL.

Fire-proof composition for roofs (Hogg, P.), ii. (1843) 94.

Fire-proof safes, viii. 147, 154.

— strong rooms, viii. 154.

FIRES, MEANS OF EXTINGUISHING.

"On the means of rendering large supplies of water available in cases of fire, and on the application of manual power to the working of fire engines." By J. Braidwood, iii. 309.—Quantity of water to be provided, 309.—Best situation for the supplies, 310.—Facilities to be afforded for the suction hose, &c., 311.—Fire tanks, 312, 322, 324, 326.—Experiments on the efficiency of jets from the mains, 312.—Apparatus required for fire supplies, 314.—Fire-plugs, stand-cocks, canvas cistern, &c., 315.—Application of power to working the engines, 319.—Hose screws, jets, &c., 320.—Plan of supply at Chelsea Hospital, 323.—Dutch apparatus for fires, 324.—Valves preferable to cocks, 325.—Improved stand-cocks at Liverpool, 325.—Jets from the mains inefficient, 326.—Supplies at Liverpool, 327.—Statement of fires in two districts in London for six years, 328.—Causes of fires, 328.—Distribution of fire-plugs, &c., at Greenwich Hospital and the British Museum, 328.—Statement of fires in London for eleven years, 330.

Discussion.—Braidwood, J., 328.—Simpson, J., 322.

— Superiority of water over chemical means (Braidwood, J.), viii. 160.

FISH-HEAD.

Fish-head for drawing a drowned clack, ii. (1842) 171.

FISHER, J., Jun. [Election, xix. 130.]

Fishing and life boats, xiii. 46.

— steamer 'Enterprise,' an account of the deep-sea, with Ruthven's propeller (Clark, D. K.), xii. 370.

FITZMAURICE, Honourable Major.

Lights, notice as to his silvered porcelain reflectors for, (Washington, Admiral), xv. 24.

FITZROY, Admiral R. [Election, xi. 477; resignation, xvi. 98.]

Air engines. The 'regenerator' in Ericson's calorific engine, xii. 350.

Batteries, floating. Application of principle of central mooring to floating batteries of large dimensions, xv. 13.

Buoys, beacons, and sea-lights, principles of mooring, xv. 11.—Practicability of examining and of changing the mooring chain, 12.—Proposed circular wrought-iron sea-light tower compared with ordinary light-vessels, 12.

Cement, nature of, xi. 505.

Coasts, &c. Direction of the currents on the south coast, near the iale of Portland, xii. 553.

Junction of the Atlantic and Pacific oceans, by the valley of the Atrato, xv. 402.

Shingle, movement of, xii. 553.

Ships, measurement of, for tonnage, xiii. 31, 62.

Telegraph cables. Marine surveys, as bearing on submarine telegraphy, xx. 60.—Outer covering of submarine cables of copper, or other substance, that would not oxidize, 61.—Paying out cables, 62.

FLAUBAT, E. [Election, xi. 478.]

FLANAGAN, T. W. [Election, xii. 432; memoir, xx. 137.]

Public works. Evils attending the mode of granting concessions for public works in Portugal, and in some other continental countries, xviii. 18.

Flap-jack for raising water, ii. (1842) 102.

FLAX-MILL.

"Description of a flax-mill recently erected by Messrs. Marshall and Co.,

FLOW OF WATER.

at Leeds." By J. Combe, ii. (1842) 142.—Dimensions, 142.—Arched roof of brick, 142.—Impermeable covering of roof, 142.—Heating and ventilation, 142.—Cost of erection, 142.—Advantages of this mode of construction, 143.

Discussion.—Braithwaite, F., 145.—Carnegie, L., 144.—Combe, J., 145.—Field, J., 145.—Marshall, J., 144, 145.—Smith, J. (Deanston), 143, 145.

FLETCHER, H. A. [Election, xviii. 231.]

FLETCHER, L. E. [Election, x. 244; Council premium, xv. 81, 104.]

Engines. Du Trembley's combined vapour-engine compared with an ordinary marine steam-engine, xviii. 281.

Locomotive engines, steam-inducted air-currents for coal-burning in, xix. 506.

Ships and steam-vessels. Dr. D. B. White's bag-water ballast, xiv. 349.—The 'Arthur Gordon,' the 'Iron Age,' the 'Anne,' and the 'Auguste Louise,' built for the iron-ore trade, and fitted with water-ballast, 353.

Steam, early experiments with superheated, particularly as applied to locomotive engines, xix. 480.—Rationale of the economy resulting from the use of superheated steam, 481.

Steam-boilers, explosions of. The theory that they are caused by the saturation of superheated steam, xv. 304.

Viaducts. "Description of the Landore viaduct, on the line of the South Wales railway," xiv. 492.—Remarks, 504.—General description, dimensions, and cost of Crumlin, Ouse Burn, Willington, Dinting Vale, Lockwood, and Denby Vale viaducts, 504.

Flint-glass, on the manufacture of, (Pellatt, A.), i. (1840) 37.

Floating clough, description of a machine called a, (Ellis, G.), i. (1839) 48.

Floor, of peculiar construction, in Smith's weaving shed, ii. (1842) 143.

Floors and roofs, clay pots and hollow bricks used for, xiv. 523.

Flow of water. *Vide* WATER, DISCHARGE OF; and WATER, FLOW OF.

Fluidity of liquids, details of some experiments on the, i. (1839) 76.

FLUIDS.

FLUIDS, BODIES MOVING IN.

"On the relation between the velocity and the resistance encountered by bodies moving in fluids." By J. M. Heppel, v. 266.—Retrospective view of the different theories for determining the, 266.—Description of a new mode for determining ditto, 267.—Numerical example of ditto, 268.—Statement of its advantages, 268.—Description of a mode by which the variable velocity of a vessel may be ascertained, 270.

Discussion.—Barlow, P. W., 289.—Berkley, G., 288.—Bidder, G. P., 275, 278, 280.—Brunel, I. K., 285.—Farey, J., 289.—Homersham, S. O., 289.—Rennie, G., 273.—Ricardo, M., 297.—Russell, J. S., 271, 279, 280, 286, 299.—Spiller, J., 279.—Stephenson, R., 280.—Walker, J., 277.

— As to using the marine engine as a dynamometer for ascertaining the resistance to bodies moving in water (Stephenson, R.), v. 430.

FLUIDS, ELASTIC.

Discharge of. "On the law which governs the discharge of elastic fluids under pressure, through short tubes or orifices." By W. Froude, vi. 356.—Common theory and formula, 356.—Causes of error in ditto, 358.—Retarding effect of expansion as the fluid issues considered, 359.—Theory respecting non-elastic fluids, 362.—Resistance of the waste steam of the locomotive, 364.—The theory of ditto compared with an indicator diagram, 367.—Rate at which air, measured at atmospheric density, will pass into an exhausted reservoir, 368.—Method of exhibiting this law by a diagram, 370.—Experiments on the discharge of air into a partial vacuum, 372.—Law of leakage into a vacuum, 373.—Appendix: Summary of proposed formulae, 375.—Ditto, tables of discharge for atmospheric air, 376.—Ditto, illustration of the occurrence of back pressure in locomotives, 377.—Ditto, detailed account of the experiments relating to the discharge of air into partial vacuum, 378.

FORREST.

Discussion.—Bidder, G. P., 385, 386, 389, 391.—Brunel, I. K., 386, 390, 391.—Froude, W., 385, 396.—Gravatt, W., 387.—Harding, W., 385, 392.—Russell, J. S., 386, 387.

Efflux of. "On the efflux of gaseous fluids under pressure." By C. Hood, i. (1840) 87.

Experiments made for M. Montgolfier, on the application of the mechanical power of carbonic acid and other gases, condensed under pressure, (Brunel, I. K.), ix. 199.—Quotations from a letter from M. Regnault, as to experiments on the effects of heat on elastic fluids, (Manby, C.), xii. 591.

Formula for the discharge of air and other fluids from tubes (Hawkey, T.), iv. 281; v. 427.—Expansion of air and steam, (Bidder, G. P.), vi. 399, 341.

Vide also AIR; AIR ENGINES; RAILWAY, ATMOSPHERIC; and STEAM.

Flushing the sewers, in the low-lying districts, south of the Thames, proposal for making use of the tidal rise of the Thames, for, xiii. 71, *et seq.*

Flushing-machine, or self-acting penstock, Salter's, xvi. 48.

Fly-wheel, Lucy's substitute for, ii. (1842) 113.

Folkestone harbour, on the motion of the shingle at, ii. (1842) 129.—Slope of sand-banks at, 129.

FOORD, H. H. [Election, xviii. 406.]

FORBES, D. [Election, xii. 272.]

FORBES, J. [Election, xii. 520.]

FORBES, Major-General W. M. [Memoir, xx. 138.]

Forbes' cylindrical ship life-boat, xii. 24.

FORDE, H. O. [Election, xvi. 226.]

Telegraph cables. Red Sea telegraph, xx. 73.—Rangoon (Malta-Alexandria) cable, 73.—Cable from Toulon to Algiers, 74.—Testing cables, 74.

Forest of Dean coal-field, i. (1840) 49.

Forging, riveting, shearing, and punching machinery, (Sawyer, T. S.), xvii. 173.

FORREST, J. [Election, xi. 477; Walker premium, iv. 4; Assistant Secretary, xvi. 187; xvii. 127; xviii. 230; Secretary, xix. 213; xx. 190.]

FORSTER.

FORSTER, F. [Election, iv. 323; memoir, xii. 157.]

Mines, ventilation of, vi. 205.—Government interference in mines, 206.—First safety-lamp introduced by Dr. Reid Clanny, 210.—Peculiarities connected with the 'Davy' and the 'Geordie' lamps, 212.—Principles on which ventilation of collieries depends, x. 45, 52.—Splitting of the air, or the separation system, 45.—Advantages of the mine-ventilator, 45.—Different means of ventilation in use in mines, 52.—Steam-jet as a means of ventilation for mines, 53.

Railway cuttings, tunnels, and mines, iii. 153.

FORSTER, T. E.

Mines. Application of the steam-jet to the Seaton Delaval colliery, x. 51.

FORSYTH, J. C. [Election, xii. 601.]

FORTESCUE, H. E. [Election, xvi. 226; memoir, xix. 173.]

FORTH, C.

Bridges. "An account of the alterations to Tullow bridge," ii. (1842) 165.

Fortifications at Fort Regent, Jersey, iii. 373.

FORSTER, Captain R. [Election, ii. (1842) 72; memoir, ii. (1843) 13.]

FOUCAULT, M.

Rotation of the earth, experiment to demonstrate the, (Cox, H.), x. 321.

FOUNDATIONS.

Barrage of the Nile, machine used under the direction of Mougél Bey for excavating the foundations at the, (Stephenson, R.), x. 368.

Chimneys, weight on the bases of some high brick, (Cowper, C.), x. 242.

Compressed air process employed in sinking the protecting cylinders, at the heads of the jetties of the steam-ferry over the river Nile, at Kaffé Azzayat, (Stephenson, R.), xvii. 64.

Deep water. "Description of the casks used for floating large stones to construct sea-walls in deep water." By J. Bremner, iii. 122.—Method of using them, 123.

Gravesend Terrace pier (Redman, J. B.), iv. 231.

FOUNDATIONS.

Holland. Amsterdam railway (Conrad, Chev. F. W.), iii. 175, 176.

In bog, vi. 150, 157, 158.

In rivers. Notice of M. Nepveu's Paper 'Note sur les fondations en rivière,' x. 365.

India. "On the mode practised in India for obtaining solid foundations for bridges, &c., in sandy soils, by means of wells." By Colonel Goodwyn, ii. (1842) 63.—Instruments used in India for sinking, 63.—Modification of system introduced by Colonel Colvin, 64.

Discussion.—Davison, R., 65.—Goodwyn, Col., 64.—Parkes, J., 64.—Sale, Col., 64.—Simpson, J., 64.—Walker, J., 65.

Natural and artificial. "On foundations, natural and artificial." By S. Clegg, Jun., x. 317.—Definition of natural foundations, and mode of building upon them, 317.—Means for creating an artificial foundation, 318.—By concrete, 318.—By caissons, 318.—By timber piling, platforms of timber, and fascines, 319.—By Mitchell's screw piles, 319.—By Potts' pneumatic cylinders, 319.—Ditto, application of, to a bridge on the Chester and Holyhead railway, 319.—Ditto, ditto, at Rochester bridge, 319.

Discussion.—Clegg, S., Jun., 320.

Potts' pneumatic process (Hemans, G. W.), xvii. 63.

Submarine. "On submarine foundations; particularly the screw pile and moorings." By A. Mitchell, vii. 108.—Circumstances which led to the introduction of the screw-pile and the screw-moorings, 109.—Proper area of the screw, 110.—Span-chain mooring, 110.—Sinker, or mooring-block, 112.—Modification of the screw-pile for holding down the buoy-chain, 113.—Comparative masses of ground which must be removed in dragging up a sinker, or mooring-block, and the screw-pile mooring, 114.—Comparative cost of screw, span-chain, and common stone moorings, 115.—System of screw-moorings in the Tyne, and apparatus employed for fixing them, 115.—Purposes to which the screw-pile

FOWKE.

has been applied, 117.—Beacons upon the banks and shoals at the entrance of the Thames, 117.—Proposal for placing a fixed light on the Dumball, at the entrance of the Avon, 117.—Foundations of the Maplin Sand lighthouse, 118.—Instrument used in trying the nature of the ground, and in testing its holding power, 118.—Raft employed in fixing the foundation piles for the Maplin Sand lighthouse, with the cost, 119.—Lighthouse erected on screw-piles at Fleetwood-on-Wyre, 119.—Description of the locality, 120.—Captain Denham's opinion of the Fleetwood and Wyre seaward lighthouse, 120.—Situation selected for the lighthouse, with details of the structure and of its cost, 121.—Comparative merits, and expense, of fixed and floating lights, 122.—Screw-pile lighthouse in Belfast Lough, 123.—Attempt to place a screw-pile lighthouse on the Kish bank, 123.—Screw-pile beacon on the Kish, the Arklow, and the Blackwater banks, 124.—Screw-pile beacon between the Queen's and Prince's Channels in the Thames, 125.—Comparative advantages of beacons and marking-buoys, 125.—Screw-pile pier, or jetty, at Courtown, 126.—Method of construction, 128.—Dimensions of the work and expense, 128.—Distinguishing features of such piers or jetties, 129.—Cast-iron screw socket-points, for whole-timber piles, and their applications, for railway signal-posts, for electric-telegraph posts, and for tent-pins, 129.—Instance of the stability and the power of holding of these screw-points, 131.

Discussion. — Brooks, W. A., 132.—Clark, —, 144.—Cubitt, Sir W., 144.—Mitchell, A., 135, 140, 142, 144.—Moorsom, Capt. W. S., 142.—Murray, J., 141.—Rennie, G. 141.—Russell, J. S., 142.—Walker, J., 136, 143.—Welbank, Capt., 138.

Vide also BRIDGES, FOUNDATIONS OF.

FOWKE, Captain, R.E.

Timber. Experiments on the strength

FOWLER.

and resistance of various woods (Dunn, T.), xvi. 304.

FOWLER, C.

Brickmaking, ii. (1843) 152.

Cattle market, necessity for the establishment of a, outside the metropolis, viii. 79.

Drainage of towns. Sewerage of Ham-burgh, xiii. 78.—Means of relieving the town district of the river Thames from pollution, and of rendering the sewage available for agricultural purposes, 107.

Scaffolding, iii. 108.

FOWLER, H. [Election, vii. 184; memoir, xiv. 133.]

FOWLER, J. [Election, iii. 66; Member of Council, viii. 44; ix. 91; x. 60; xi. 84; xii. 112; xiii. 123; xiv. 97; xv. 76; xvi. 88; xvii. 70; xviii. 164; Vice-President, xix. 132; xx. 108.]

Arches, stone, stability of, x. 302.

Bridges. Dimensions and construction of the Torksey tubular bridge, and the effect of the continuity of the girders, ix. 245.—Thickness of the plates in various parts of the bridge, and their arrangement, 272.

Colliers. Cost of working expenses, and work performed, by a sailing collier, xiv. 358.

Drainage of land. Suggested commission for carrying out works of arterial drainage, xix. 99.—Principles of arterial drainage, illustrated by reference to the Ancholme, the Witham, the Nene, and the Ouse, 100.

Drainage of towns. Mode of providing for the sewage of the metropolis, xv. 233.

Masonry, x. 302.

Permanent way, iron, and different varieties of permanent way, xx. 276.

Rivers and estuaries. Probable effect of the construction of chain of locks at London bridge, xv. 234.—Division of tidal rivers into two classes, 235.

Roofs, cost of three iron, xiv. 264.—Weight of iron in different roofs, 268.—Weight of roof as compared with span, 271.

FOWLER.

- Tunnels. Construction and enlargement of the Lindal tunnel, on the Furness railway, xix. 238.—Construction of the Netherton tunnel, on the Birmingham canal, xix. 280.
- Viaduct, iron, at Manchester, xi. 233.
- Fowler's extended joint chairs, xi. 261, 284; xvi. 233.
- FOWLS, S. [Memoir, viii. 11.]
- Fox, Sir C. [Election, i. (1839) 9.]
- Artillery, construction of, xix. 371.
- Axles, solid and hollow, ii. (1843) 94.
- Bridge, Newark dyke, on the Great Northern railway, xii. 608.
- Engines. Difference between the action of marine and stationary engines, viii. 307.
- Exhibition in 1851, construction of the building for the, x. 188.
- Foundations. Estimated cost of ordinary coffer-dams and piers for the new bridge at Rochester, compared with the actual cost of piers founded according to the pneumatic method, x. 366.
- Iron made by Clay's process, ii. (1843) 86.—Causes of asserted bad quality of iron, xii. 379.—Durability of galvanized iron, xiv. 265.—Coating iron with zinc alone, 266.
- Mines, experiments on the temperature of, ii. (1843) 141, 142.
- Permanent way of the Brighton and Chichester railway, v. 242.
- Railway trains, resistances to, vii. 320.
- Roofs, iron, cheapest span for, xiv. 265.
- Telegraph cables, submerging, and difficulty to be apprehended in deep water, from the probable existence of deep-sea currents, xvii. 326.—Conducting medium, 327.
- Telegraph instrument, Mr. Henley's magnetic, xvi. 218.
- Fox, D. M. [Election, xix. 489.]
- Fox, Dr.
- Fire-proof flooring (Barrett, J.), viii. 162.
- Fox, F. [Election, xix. 546.]
- Permanent way. "On the results of trials of varieties of iron permanent way," xx. 259.—Remarks, 275, 286.—

FREEMAN.

- Cost of maintenance on the Macdonnell system, and additional outlay in the first instance, 287.—Action of frost upon the iron way, 288.
- FRANCIS, A.
- Pipe-drains, unglazed earthenware, xii. 78.
- FRANCIS, C. L. [Election, i. (1838) 5.]
- Beams. "On the brick beam at Nine Elms," i. (1838) 16.
- FRANCIS, J. [Election, viii. 206; resignation, xiv. 108.]
- Cement, Roman, xi. 505.
- FRANCIS, J. (Manchester).
- Pipe-drains, extract from a letter from, as to the state of the, at Manchester (Cawley, C. E.), xii. 80.
- Franklin Institute, result of experiments on water-wheels, ii. (1843) 64.
- Franklin's (B.) system of propulsion somewhat similar to Ruthven's, xiii. 374.
- FRASER, —.
- Gas, results of the use of clay retorts for making, in Scotland, xvi. 321.
- FRASER, A.
- Smoke, prevention of, Juckes' apparatus for, xiii. 406.
- FRASER, J.
- Axle-boxes, new system of, not requiring lubrication, and without liability to heating, xviii. 415.
- FRASER, Lieutenant E., B.E. [Election, xi. 241; memoir, xx. 163.]
- Fraser's centering for tunnels, ii. (1842) 141.
- FREAKE, C. J. [Election, xix. 625.]
- FREEMAN, J. [Election, ix. 375.]
- Exhibition in 1851, probable effect of the wind on the building for the, x. 180.
- Fire-arms. Colt's revolvers and pistol on similar principle, by Messrs. Deane, Adams, and Deane, xi. 56.
- Railway axles, necessity for the use of the best iron for, ix. 302.
- Safety-valves, application of cup-and-ball principle to, xv. 41.
- FREEMAN, W. [Auditor, i. (1839) 27.]
- Friction of air in pipes, i. (1837) 43.
- on roads, railways, canals, &c., dynamometer for measuring the, (Carr, H.), i. (1840) 52.

FRODSHAM.

Friction of beam and direct action steam engines (Pole, W.), ii. (1843) 69. *Vide* also **STEAM ENGINES**.

— general laws of, ii. (1843) 69, 71, 72, 73 *et seq.*

Frith of Murray, xx. 322 *et seq.*

FRODSHAM, C. [Election, v. 338; Telford medal, vii. 3.]

Chronometers. "On the laws of isochronism of the balance spring, as connected with the higher order of adjustments of watches and chronometers," vi. 224.—Remarks, 251.—Prevailing want of knowledge of the laws of isochronism, 251.—Remontoir escapement, 251.—Application of oil for diminishing the friction in chronometers, 251.—The chief incentive to the improvement of horology, the public trial of chronometers at the Royal Observatory at Greenwich, 252.—Chronometer constructed with the Arnold escapement, 252.—Plan of tapering springs, 252.—Causes which affect the extent of the arcs of vibration in watches, 253.—Lever watch the most useful for the pocket, 253.—Calculation of 'the middle temperature error' of chronometers, 253.—Difficulty of hardening and tempering the balance spring, 254.—Opinion of Sir John Herschel on the tendency of empirical art, 254.

FROME, Lieutenant, R.E. [Election, i. (1838) 41.]

FROER, S. [Election, v. 340; resignation, xiii. 134.]

FROUDE, W. [Election, v. 338.]

Fluids, elastic. "On the law which governs the discharge of elastic fluids under pressure, through short tubes, or orifices," vi. 356.—Remarks, 385.—Experiments relative to the discharge of air into a partial vacuum, 385.—Formula for ditto, 385.—Discharge of elastic fluids under pressure, 396.

Railway curves, application of the arcs of a cubic parabola to, (Gravatt, W.), ii. (1843) 110.

Steam. Effect which the cooling of the steam, due to its expansion, produces upon its elasticity, vi. 387.

FULTON.

FRY, A.

Bells at the New Palace, Westminster xix. 18.

FUEL.

Coke and coal, relative heating effects of, (Parkes, J.), i. (1838) 29.

— "On the relative heating powers of coke and coal in melting glass." By A. Pellatt, i. (1838) 39.

Discussion.—Parkes, J., 40.—Pellatt, A., 40.

Combustion of different kinds of, i. (1840) 66, 67.

— "On the combustion of fuel in furnaces and steam boilers, with a description of Bodmer's fire-grate." By J. G. Bodmer, v. 362.—Notice of the application of Bodmer's fire-grate to a boiler at Old Ford, and to an engine on the Croydon railway, 366.—Recommendation and reasons for diminishing the draught, 366.

Discussion.—Bodmer, J. G., 368.—McConnell, J. E., 368.—Taylor, J., Jun., 368.

Consumption of, in locomotive engines (Harrison, T. E.), i. (1837) 38.

—, in Cornish and marine engines, (Field, J.), vii. 42.

Mechanical values of, for evaporation (Clark, D. K.), xvi. 5, *et seq.*

Peat, used for smelting iron, i. (1839) 29 *et seq.*

— and resin. "On the properties, and composition of the peat and resin fuel." By O. W. Williams, i. (1839) 38.—Manufacture, 38.—Heating effects, 39.

Discussion.—Cottam, E., 42.—Horne, J., 41.—Lowe, G., 40, 42, 69.—Parkes, J., 68.—Pellatt, A., 42.—Taylor, J., 41.—Williams, O. W., 69.

Vide also **ANTHRACITE**; **COAL**; **FURNACES**; **IRON**; **LOCOMOTIVE BOILERS**; **LOCOMOTIVE ENGINES**; **RAILWAY INCLINES**; **SMOKE**, **PREVENTION OF**; **STEAM**; **STEAM BOILERS**; **STEAM ENGINES**; and **STEAM NAVIGATION**.

FULLER, G. L. [Election, xviii. 72.]

FULTON, H. H. [Election, iv. 291.]

FULTON.

FULTON, R.

Canals. Plan proposed by him, for working a canal from Ambletouse to Guisnes without lockage (Gibbs, J.), xiii. 209.

FURNACES.

Air, iron re-melted in, rendered hard (Field, J.), ii. (1843) 130.

Blast, quantity of air entering, (Farey, J.), i. (1840) 67.—Best shape for, (Hardie, T. G.), ii. (1842) 61.—Furnace used in making iron by Clay's process (Clay, W. N.), ii. (1843) 82, 83, 84.—Description of those at the Butterley iron-works (Kreeft, S. C.), 119.—Egyptian arch used in the construction of ditto, 120.—Barrow and mode of filling, 120.—At the Milton iron-works, blown with heated air, 126.—Pressure of the blast, 126.—Chemical combinations in blast furnaces (Farey, J.), 129.—Process of smelting with hot blast, 129.—Dryness of the blast, essential for making good iron, 130.—Present knowledge of the effects of hot blast very limited (Rennie, G.), 130.—Hot blast used at Ynischedwyn, and cold blast at Ystalyfera, with anthracite, (Brunton, W.), 180.—Black-band iron-stone found at the Beaufort

FYFE.

iron-works, and the furnaces there blown with hot blast, 131.

Cupola, preferable for melting iron (Field, J.), ii. (1843) 130, 131.

Forms of, for smelting hematite ores (Clay, W. N.), iii. 235.—Gibbon's improvement in the, (Slate, A.), 246.—Form of the Conegree furnace, Dudley, 246.—Dimensions of, and experiments upon the blast engine of ditto, for blowing furnaces, 247.—Best pressure of blast, 247.—Working of blast furnaces (Fairbairn, W.), xii. 375; (Percy, Dr.), 375.

Pyrometer for indicating the rise or fall of the temperature in, (Williams, C. W.), xiii. 402.

Vide also IRON ORES; IRON-WORKS; and SMOKE, PREVENTION OF.

Fuse, 'pillar,' for sea-service shells of rifled ordnance, and difference of conditions required for sea service and for land service, xx. 474.

Fuses, time and concussion, used with the Armstrong artillery, xix. 409.

FYFE, A.

Anthracite. "On the combustion of anthracite, and its value as a fuel for steam-engine and other furnaces," i. (1841) 154.

G.

GALE.

GALE, J. W. [Election, xiii, 383.]

GALE, W.

Cranes, iii. 214.

— "Remarks on the utility and defects of the movable jib-crane, according to the construction now generally used in Glasgow, with proposed improvements to obviate its defects," iv. 333.

GALLEZ, M. [Election, xii. 109.]

GALLOWAY, E.

Iron, cast, heat evolved by, after being long immersed in salt water, iii. 86.

Naval construction, &c. Cast-iron protectors tried on the 'Magicienne' frigate, iii. 87.

Pump-valves, iii. 96.—Trapezium valve, 96.—Heart-shaped valve, 96.

Screw-propellers, iii. 75, 80, 84, 85.

GALLOWAY, J. A. [Election, i. (1839) 42; memoir, x. 81.]

GALTON, Lieutenant D. S., R.E. [Election, ix. 232.]

Galvanic action, changes in cast iron induced by, ii. (1842) 153.—Between the metal faces of valves, ii. (1843) 197.—Of zinc in protecting cast iron from corrosion, iii. 253.

Galvanism, on firing blasts under water by, (Bethell, J.), i. (1838) 35.

—, development of the powers of, vi. 26.

Galvanized iron, xiv. 265, 272.

Galvanometer, Becquerel's common differential, xx. 39.

GALY-CAZALAT, M.

Air-engines. His examination of Ericsson's new engine (Manby, C.), xii. 558.

GANDRELL, J. [Election, i. (1841) 78; resignation, viii. 9.]

GANT, S. C. [Election, i. (1839) 70.]

GARDE, DE LA, *vide* DE LA GARDE.

GARDINER, R. B. [Election, xviii. 72; memoir, xix. 188.]

GARDNER, J. [Election, x. 326.]

GAS.

GABRIEL and Co.

Cements. Reference to their establishment for the manufacture of Vassy cement, and works executed in that material (Rennie, G.), xvi. 428.

GARLICK, E. [Election, xx. 191.]

GARNETT, G. [Election, xviii. 296.]

GARRETT, R. [Election, xi. 299; memoir, xviii. 188.]

GARRETT, R., Jun. [Election, xiii. 364.]

GARBOD, Dr.

Stone, manufacture of artificial, with a silica base, vii. 65, 69.

'Garry Owen' iron steamer, durability of, ii. (1843) 178.

GAS.

Bursts of, in the Thames tunnel (Brunel, Sir M. L.), ii. (1843) 81.

Clay retorts for making. "On the results of the use of clay retorts for gas making." By J. Church, xvi. 309.—Mr. D. Gordon's compressed gas, 309.—Mr. Grafton's fire-clay retorts, 309.—Mr. S. Clegg, Jun.'s opinion as to ditto, 310.—Comparative quantities of gas made by iron and clay retorts, 310.—Form to be preferred, and cost of setting, 311.—Necessity to work at a low pressure when an exhaustor is not used, 311.—Method of working clay retorts with an exhaustor, 311.—Deposition of carbon, from the decomposition of gas at a high temperature, 312.—Means for the removal of this carbonaceous incrustation, 313.—Quantity of fuel required for carbonizing the coal in iron and in clay retorts, 314.—Principal advantages arising from the use of clay retorts, 314.

Discussion.—Church, J., 325.—Evans, F. J., 318.—Fairbank, J. F., 322.—Fraser, —, 321, 322.—Goddard, E., 321.—Gore, H., 315, 319.—Hawksley, T., 323.—Maugham, Dr., 322.—May, O., 319, 322.—Ramsay, G. H., 326.—

GAS-BURNERS.

- Siemens, C. W., 320.—Strode, W., 320.
 —Wright, A., 316.
 Distribution of, (Simpson, J.), xiii. 202.
 Invention and gradual introduction of, (Rennie, Sir J.) v. 62.
 Leakage of, (Lowe, G.), iv. 220.
 Manufacture of, (Rennie, Sir J.), v. 62; (Simpson, J.), xiii. 202.
 Measurement of. "On the measurement of gas, and the classes of gas meters in general use." By W. Orosley, xix. 674.
 Products of combustion of, (Faraday, J.), ii. (1843) 185.
 Purification of. "On the purification of coal gas, and the application of the products thereby obtained, to agricultural and other purposes." By A. A. Croll, iii. 290.—Quantity made in London, 290, 300.—Chemical composition of, 291.—Impurities of, 291, 294.—Employment of the products of the manufacture, 291, 302.—Sulphuric acid used in purifying gas, 292.—Production of sulphate of ammonia, 293.—Wet and dry lime purifiers, 294.—Saving arising from the acid purifying process, 295.—Products of purifying used for agricultural purposes, 297.—Expenses of ditto, 300.
 Discussion. — Bethell, J., 303. — Cooper, J. T., 307.—Farey, J., 304.—Graham, Prof., 302.—Lowe, G., 301, 304.—Murray, A., 304.—Simpson, J., 303.—Walker, J., 308.
Vide also GAS BURNERS; GAS LIGHTING; GAS METERS; GAS REGULATOR; GAS WORKS; LIQUID HYDROCARBONS; and MINES, Lighting.
 Gas-burners, ii. (1843) 190; v. 433; vii. 85; xi. 477. *Vide also* LAMP-BURNERS, Ventilation of.
 Gas lighting, vii. 36.—Defective state of, in metropolitan thoroughfares, 85.—Sir Humphrey Davy's investigations in regard to, 100.
 — On the application of certain liquid hydrocarbons to artificial illumination; with a description of a new method of gas lighting (Manafield, C. B.), viii. 207.
 — in mines (Wright, A.), xvii. 1.

GASTINEAU.

GAS METERS.

- Construction of. "On the construction and use of gas meters." By A. A. Croll, iv. 211. — Amount of leakage from the gas pipes, 213.—Description of the water gas-meter, 215.—Ditto of the first dry-meter, 215.—Ditto of Sullivan's dry-meter, 216.—Ditto of Defries' dry-meter, 216.—Ditto of Croll and Richards' meter, 217.
 Discussion.—Cooper, J. T., 219.—Croll, A. A., 218, 221.—Defries, J., 218.—Farey, J., 219, 220, 222.—Lowe, G., 220.—Moorsom, Capt. W. S., 219.—Pellatt, A., 222.—Stevens, J. J. 219.
 Dry. "On the dry meter." By S. Clegg, i. (1838) 14.
 —, Defries, ii. (1842) 89.
Vide also GAS.
 Gas pipes, vibrations of a pressure gauge attached to a line of, i. (1841) 149.—Porosity of, iii. 304.—Manufacture of, iv. 220.
 GAS REGULATOR.
 "Description of a new gas regulator." By J. Milne, i. (1840) 61.
 Discussion.—Lowe, G., 61.
 Gas-stove, Goddard's portable asbestos, xi. 477.
 GAS WORKS.
 Extension of, (Simpson, J.), xiii. 202.
 Machinery for. "Account of the machinery and apparatus for compressing and using gas for artificial illumination at the portable gas works of London, Edinburgh, Manchester, and Paris." By C. Denroche, ii. (1842) 187.—Improvements in ditto, by David Gordon, 187.—Pressure necessary for, 138.
 Middlesborough-on-Tees. "Specification and working drawings of the Middlesborough-on-Tees gas works." By P. Henderson, i. (1840) 6.
 Pressure gauge for indicating small amounts of pressure, (King, A.), ii. (1843) 192.
 Gaseous fluids under pressure, on the efflux of, (Hood, C.), i. (1840) 87.
 Gases evolved in mines, vi. 161.
 GASTINEAU, J. [Election, v. 248.]

GATES.

- Gates, flood and tide, on the new works of the river Lee, xiii. 244.
- Gauge for ascertaining the parallelism of a railway, (Cowper, E.), i. (1840) 30.
- , cramp, used in laying the rails of the South Eastern railway, ii. (1842) 76.
- , pressure, used at the Liverpool gas-works for indicating small amounts of pressure, ii. (1843) 192.
- Gauge Commissioners, Report of the, remarks as to the, vii. 322 *et seq.*
- Gauges, steam pressure, and other instruments for measuring temperatures and pressures (Bourdon, E.), xi. 14.
- Gault, a bad material for embankments, vi. 158.
- GRAICH, C. [Election, x. 57; Member of Council, xiii. 123; memoir, xviii. 148.]
- Axles, comparative strength of solid and hollow, ii. (1843) 91.
- "Account of a series of experiments on the comparative strength of solid and hollow axles," iii. 201.
- GEOLOGY.
- Geological sections of railway cuttings (Sopwith, T.), i. (1841) 61.
- Isle of Wight, positions of strata (Simpson, J.), xiv. 93.
- Models, for familiarly explaining geological phenomena (Sopwith, T.), i. (1841) 62.
- "On the construction and use of geological models in connection with Civil Engineering." By T. Sopwith, i. (1841) 163.—On the application of modelling to engineering and mining purposes, 163.—The materials to be employed, 164.—The mode of construction, 164.—On the scales to be employed, 165.—The objects to be represented, 165.—On the use of, by civil engineers, 166.
- Discussion.—Buckland, Dr., 166.
- Soils, mode of testing by quantity of water contained (Rendel, J. M.), ix. 17.
- Study of, as a part of engineering (Rennie, Sir J.), v. 107.—Importance of a knowledge of geology to Civil Engineers, (Buckland, Dr.), vii. 243; ix. 15; (Rendel, J. M.), 16.

GIBBS.

- Geology, in the field by mining engineers, xvi. 57, *et seq.*
- Western India, of district traversed by Great Indian Peninsular railway, (Barkley, J. J.), xix. 599.
- Vide also* CHALK; COFFER-DAMS, Great Grimsby; GOLD; LONDON BASIN; RAILWAY CUTTINGS AND EMBANKMENTS; RAILWAYS, Indian; WATER SUPPLY; and WELLS.
- 'Geordie' lamp, vi. 166.
- GIBB, J. [Memoir, x. 81.]
- Engine-houses, &c., mode of securing the foundations of, recommended by him (Simpson, J.), ii. (1843) 138.
- Water-works, reference to his being consulted relative to the Glasgow (Simpson, J.), ii. (1843) 137.
- GIBBINS, T. [Election, viii. 164; resignation, xiv. 108.]
- GIBBONS, B.
- Mines, extracts from his treatise on the ventilation of, describing the system adopted by him at the Shut End colliery, Staffordshire (Stephenson, R.), vi. 197.
- Railway, atmospheric, iii. 272, 274.
- GIBBS, —.
- Coffer-dams, stony ground, construction of, i. (1837) 35.
- GIBBS, J. [Election, xi. 422.]
- Beams, experiments upon brick, xi. 504.
- Canals. Means of avoiding lockage in China, and analogous plan, proposed by Fulton, for making a canal from Ambletense to Guisnes, xiii. 209.—System of lockage and pumping preferable to that of inclines on canals, 210.
- Chalk, absorbing powers of, xx. 213.
- Coasts, &c. Movement of shingle, and travel of beach, xii. 551.
- Diving apparatus, Deane's, xv. 327.
- Docks, advantage of sea outlet at Sunderland, xv. 451, 455.
- Drainage of towns, xii. 94.—Drainage and sewerage of the metropolis, xv. 225.—Size of sewer outlets, 451.
- Iron. Process of iron-making, and as to working of blast-furnaces, xii. 376.
- Junction of the Atlantic and Pacific

GIBSON.

oceans. Feasibility of constructing a canal from Panama to Chagres, xv. 407.

Mines. Importance of keeping mines continually full of fresh air, xii. 306. —Mining schools for the education of 'overmen,' 310.

Rivers and estuaries. Probable effect of making a dam across the Thames at London bridge, xv. 224. — Bar off Oporto, and how bars are produced, 453. — Rise and fall of the river Wandle, its springs, tributaries, and pollution, xx. 212, 233. — Pollution of rivers by the discharge into them of town drainage and sewage, 233.

Sluicing, the effect of, at the harbours of Dunkirk, Boulogne, and Ostend, xv. 451. — Object to be obtained by sluicing, 453.

Water-supply to be derived from the sandstone, xii. 504.

GIBSON, J.

Glasgow, history of, ii. (1843) 134.

Railway axles, form of, ix. 301.

Gibson's self-acting railway signals, xvii. 51.

GILBERT, D. [Memoir, i. (1840) 12.]

GILBERTSON, W. [Election, ii. (1842) 122.]

GILDEA, J. N. [Election, xii. 520.]

GILES, A. [Election, v. 248; Telford medal, xviii. 174.]

Breakwaters, form and materials for, xix. 662.

Buoy in the Solent, near Southampton, xx. 309.

Coffer-dam at Southampton, ix. 20.

Concrete, use of, for foundations and for the back of retaining walls, xvi. 437.

Diving apparatus, its cost, and daily cost of working, xv. 326.

Docks. "On the construction of the Southampton docks," xvii. 540. — Remarks, 553. — Cost of the coffer-dam for reconstructing one of the dock walls, 553. — Section of the wall of concrete, with a facing of Purbeck stone, 554.

—, Tyne, particularly form of invert of the lock, xviii. 504.

—, Victoria (London), xviii. 479.

Lock-gates, comparative cost of iron and

GIRDERS.

of wooden, xviii. 482. — Use of hydraulic apparatus for opening and closing, 482, 504.

Mortar, manufacture of, x. 301.

North Sea. Formation of the Dogger Bank, xx. 345, 347.

Pier at Southport, Lancashire, xx. 298.

Piles, driving, xviii. 504.

Rivers and estuaries. Tidal phenomena in the Frith of Forth, xx. 345.

GILES, F. [Election, ii. (1842) 138; Member of Council, iii. 66; iv. 62; memoir, vii. 9.]

Bridges. Old London bridge, ii. (1843) 87.

Clocks, best material to be used for the pendulums of, iv. 73.

Drainage, iv. 201.

Harbours. Dover, iv. 320. — Bridport, Shoreham, and Sunderland, 321.

Permanent way. Cost of compressed oak keys, iv. 56.

Piles, driving, iii. 200.

Rivers. Improvement of the Severn, iv. 370.

Scaffolding used at Corby bridge, iii. 208.

GILES, F. [Election, xx. 375.]

GILES, G. [Election, v. 478.]

GILKER, E. [Election, xviii. 231.]

GILL, H. [Election, xx. 106.]

GILL, J. E. [Election, x. 244.]

GINTY, W. G. [Election, xx. 258.]

GIRDERS.

Cast-iron, at a London brewery, accident to, and explanation of the causes of, (Braithwaite, F.), xiii. 464. — Strength of, (Errington, J. E.), 474. — Of cast and wrought-iron (Hawkshaw, J.), 474. Exhibition in 1851, roof girders and trusses of, (Wyatt, M. D.) x. 143.

Gravesend terrace pier, cast-iron, used for (Redman, J. B.), iv. 237; (Fairbairn, W.), 247.

Iron, contrasted with cast-iron arches, xviii. 356, *et seq.*

Overloading, as to risk of, (Hawkshaw, J.), xiii. 474; (Simpson, J.), 475.

Permanent set, absence of, in girders, the exception, not the rule (Dinea, T.), xviii. 472.

GIRDERS.

Proportions of. "On the relative proportions of the top, bottom, and middle webs of iron girders and tubes." By J. M. Heppel, xv. 155.—Inquiry as to joint effect produced upon an elastic plate by various forces, compressive and tensile, simultaneously applied to it in different directions, 155.—Investigation of the effect of forces applied in couples, or what are often termed 'shearing forces,' 160.—Application of results obtained to beams, 164.—Inquiry as to correction which must be applied to the thicknesses previously determined, to enable the plate to resist the resultants, arising from the combination of the horizontal and diagonal forces, 169.—Comparison of the dimensions which would result from the process described, with those of the Conway tube, 171.—Remarks on the vertical pillars connecting the top and bottom members of wrought-iron tubes and beams, 175.—Appendix, 178.—Ditto, Art. I., determination of maximum and minimum values of resultant force, 178.—Ditto, Art. II., proof that any number of applied forces may be replaced by their principal resultants, 178.—Ditto, Art. III., proof that if the applied forces are two in number, equal, of the same kind, and at right angles, the resultant force is the same in all directions, and equal to either of the applied forces, 179.—Ditto, Art. IV., proof that if the applied forces are at right angles, but unequal, they are themselves the principal resultants, 180.—Ditto, Art. V., proof that if the applied forces are of the same kind, and equal, but not at right angles, the principal resultants bisect the angles between them, 180.—Ditto, Art. VI., proof as to neutral direction, where the resultants are of different kinds, 180.—Ditto, Art. VII., proof that the sum of the two principal resultants, with their proper signs, is equal to the sum of the original forces, with their proper signs, 180.—Ditto, Art. VIII., determination of correction to be applied to principal

GISBORNE.

resultants, 181.—Ditto, Art. IX., examination of four different cases of distribution of the load upon a beam, 181.—Ditto, Art. X., investigation of the manner in which the forces are affected by a change in the thickness, 185.—Ditto, Art. XI., investigation of the value of the resultants, 186.—Ditto, Art. XII., manner in which the resultant forces in action at any given point may be determined, 188.—Example; application of the equations to the case of the Conway tube, 190.
Discussion.—Clark, E., 192.—Heppel, J. M., 191.—Hodgkinson, Prof., 193.—Stephenson, R., 193.
Strength of. "On the strength of iron girders." By W. B. Bray, i. (1837) 29.
—— "On Mr. Hodgkinson's experiments on cast-iron girders." By T. Webster, i. (1837) 30.
—— "Experiments on the strength of iron girders." By T. Cubitt, i. (1841) 116.
—— Mr. Eaton Hodgkinson's formula for calculating the, (Stephenson, R.), vi. 223.
——, (Fairbairn, W.), xiii. 470; (Grisell, H.), 471.—Experiments as to, (Dines, T.), 471.
Trussed. "Description of a new system of trussed girder of wrought and cast iron for bridges." By F. Naah, iii. 102.—Experiments on the strength of, 103.
—— cast-iron, with wrought-iron tie-rods, used for railway bridges, (Stephenson, R.), vi. 219; (Bidder, G. P.), 220; (Vignoles, C.), 220.
Warren, principle of, as developed in the construction of the Newark Dyke bridge, xii. 601, *et seq.*—Structure of, (Bidder, G. P.), xiv. 475.
Vide also BEAMS; BRIDGES; EXHIBITION in 1851; FIRE-PROOF BUILDINGS; IRON; METALS, Fatigue and fracture of; and VIADUCTS.
GISBORNE, L. [Election, xi. 478.]
Junction of the Atlantic and Pacific oceans, by the Darien route, xv. 397.—Ditto, by the Atrato, 398, 400.—Ditto, by Panama, 399.—Barometric observa-

GLADSTONE.

tions, 400.—Mean level of the Atlantic and Pacific oceans, 406.—Rise of tide in ditto, 406.

Railways, advantages that would result from an extension of the system of county and baronial guarantees to, in Ireland, xviii. 40.—Funds obtained through the action of the Encumbered Estates Court, 43.

Telegraph cables, submerging. Comparative advantages of light and heavy cables, and proposed plan of paying-out machinery, xvii. 317.

GLADSTONE, T. M. [Election, v. 340.]

Iron and steel, Bessemer process for the manufacture of malleable, xviii. 550.

GLAISHER, J,

Electric telegraph, necessity for lessening the cost of batteries, and experiments on long line of, in the United States, xi. 382.

Rainfall. Table of the instances of the fall of rain, amounting to more than half an inch within twenty-four hours, during the years, 1851-52-53, xiii. 115.

Glasgow, population of, at various periods, ii. (1843) 134, 135.

—, supply of water to the city of, (Mackain, D.), ii. (1843) 134.

GLASS.

Atomic character of, (Clay, W. N.), iii. 232.—Difficulties in the production of a uniform quality, 232.—Mixtures for various qualities, 233.—Lenses for optical purposes, 233.

Manufacture of. Relative heating powers of coal and coke for melting glass (Pellatt, A.), i. (1838) 39.

— "On the manufacture of flint glass." By A. Pollatt, i. (1840) 37.—Ditto of flint plate, 38.—The elastic properties of flint glass, 38.—On annealing, 39.

Discussion.—Hawkins, J. I., 41.—Parkes, J., 40.—Pellatt, A., 39, 40.

—, substitute of mica for, in the windows of workshops (Glynn, J.), i. (1840) 43.

GLASS, R. A. [Election, xvii. 483.]

Glazing machine used in the construction of the building for the Exhibition of all Nations in 1851, x. 160.

GLYNN.

GLYNN, J. [Telford medal, vii. 3; Council premium, xi. 87, 118.]

Anthracite, use of, for smelting at the Ystalyfera iron-works, viii. 113, 115.—Mode of using, under a steam-boiler, and analyses of three specimens of, by Sir R. Kane, 116.

Beams, value of continuous, ix. 273.

Bridges. Effect of the velocity of trains passing over a bridge, ix. 273.

Coal-mines, explosions in, x. 22.

Hydraulic machinery. Employment of water-pressure for mechanical power, and the economy of its applications, ix. 384.—Westgarth's water-pressure engine at Allendale, 384.—Ditto in the lead-mines at Bakewell, 385.

Iron, decay of cast, in coal-mines, vii. 158.—Mode of applying heated vapours in the manufacture of, and their analyses, viii. 116.—Proportions of the materials employed, and of the machinery and arrangements for smelting, 116.

Isthmus of Suez. "On the Isthmus of Suez, and the canals of Egypt," x. 369.—Remarks, 376.

Junction of the Atlantic and Pacific oceans. "A review of the plans which have been proposed for connecting the Atlantic and the Pacific oceans by a navigable canal," vi. 399.—Remarks, 427.—Reasons for bringing forward this subject, 427.

—, M. Garella's survey, and geological formation of the country, ix. 73.—Most advisable route for the passage of the Isthmus, 80.

Machines. "Description of a sawing-machine for cutting off railway bars," i. (1839) 51.

Mica. "On the use of mica as a substitute for glass in the windows of workshops," i. (1840) 43.

Mines. Coal-mining, particularly in the Midland districts, viii. 133.—Ventilation of mines, 184.—Extract from Mr. Dunn's work "On the winning and working of collieries," particularly in reference to ventilation, 135.

Permanent way, ix. 405.

GOATER.

Pipes, rapid destruction of iron, in coal-mines, ii. (1842) 154.

Pump-valves, ii. (1843) 199.

Railway axles. "On the causes of fracture of the axles of railway carriages," iii. 202.

Rainfall in different parts of England, the amount lost by evaporation and absorption, and the quantity flowing off the ground, vii. 275.

Steam, expansive action of, vi. 337.

Steam-boilers, explosions of, xi. 398.

Water-wheels, iii. 68.—Construction of, with ventilated buckets, viii. 61.

Working-classes in England and America. Are American mechanics better educated than the same class in England, xi. 63.

GOATER, W.

Locks and keys. Picking Mr. Hobbs' protector locks, xiii. 269.

GODDARD, E. [Election, ix. 232.]

Gas. Portable asbestos gas-stove, xi. 477.—Protected gas-burner, 477.—Results of the use of clay retorts for making gas, xvi. 321.

GODWIN, G.

Fire-proof buildings. Present mode of constructing buildings, in reference to their insecurity against fire, viii. 152.—Provision in the present Act of Parliament, insisting on access and staircases to public buildings being made fire-proof, 158.

GODWIN, J. [Election, iv. 372.]

GOLD.

"On the vertical structure of the primary rocks, and the general character of their gold-bearing varieties." By E. Hopkins, xv. 48.—Interesting natural process of the development of gold from granite, in South America, 52.—Points indicating the possible existence of gold in any given district, 53.—Auriferous veins worked on the ordinary system of mining, 53.—Ordinary gold-diggings, 54.—Extraction of gold from superficial deposits, 54.—Definitions of terms 'drift' and 'alluvium,' 54.—Earnings of gold-diggers, and reasons why companies do not make

GOOCH.

great profits, 54.—Value of gold obtained since 1851, from California and the colony of Victoria, 55.

Discussion.—Calvert, J., 60, 62.—Hawkshaw, J., 59.—Hopkins, E., 57, 68.—Manby, C., 73.—Maugham, Dr., 62.—May, C., 62.—Mushet, D., 6.—Simpson, J., 74.—Smyth, W., 60, 63.—Taylor, J., 58.—Taylor, J., Jun., 58, 61, 62.—Tennant, Prof., 62.—Tyndall, Prof., 67.—Vignoles, C., 58.

Gold districts of Virginia, in the United States, xv. 69.

— fields of Victoria, New South Wales, xv. 72.

— leaf, the most delicate test for detecting the presence of mercury, ii. (1842) 84.

— regions of California, xv. 71.

GONOT, M.

Mines. Introduction of the system of lighting Belgian mines by means of coal-gas (Burnell, G. R.), xvii. 9.

GOOCH, D.

Coal, use of the semi-bituminous, from the Taff Vale, in some of the locomotives on the Great Western railway, viii. 110.

Railway trains, resistances to, extracts from a letter from him, on determining the, with details of experiments (Reunnie, Sir J.), v. 416.

— "Observations on the resistances to railway trains at different velocities," vii. 292.—Remarks, 306.—Mode of conducting experiments for ascertaining the, 306.—Experiments on the speed of trains descending the incline planes of the Great Western railway, 309, 318.

GOOCH, J. V. [Election, xiii. 421.]

Locomotive engines, construction of, the distribution of the weights on the wheels, and the evils of large engines, viii. 244.—Advantages resulting from the correct equilibration of the engines on the Eastern Counties railway (Bidder, G. P.), xvi. 36.

Steam-boilers, means of preventing the incrustation of, particularly those of locomotive engines, v. 195.—Successful

GOOCH.

application to an engine belonging to the London and South Western railway company, of muriate of ammonia on Dr. Ritterbandt's plan, 196.—Ditto to sea-going boilers, 196.—Cost of applying muriate of ammonia to a locomotive engine, v. 197.—Peculiar action of muriate of ammonia, 210.

GOOCH, T. L. [Election, iv. 323.]

Good, S. A.

Decimal coinage, xiii. 339.

GOODEVE, T. M. [Election, xii. 432.]

Goodwin Sands, formation of, iv. 321.—Beacons, caissons, and lighthouses proposed for, vii. 138.

GOODWYN, Colonel H., B.E. [Election, i. (1841) 163.]

Foundations. "On the mode practised in India for obtaining solid foundations for bridges, &c., in sandy soils, by means of wells," ii. (1842) 63.—Remarks, 64.—Well-sinkers working under water, 64.—Extract from his paper, with woodcuts of tools used, xvi. 455.

GORDON, A.

Air-engines. Stirling's air-engine, iv. 356, 359.—Application of heated air, or the hot products of combustion, as a motive power, ix. 197.—Difference between the carbonic acid and the hot-air engines, 200.—Employment of a permanently elastic fluid, 201.—Wear and tear of machinery due to high temperatures, 202.—Fumific impeller, 202.—Expansion of air by heat, and the mechanical power to be obtained from it, 203.

Boilers, use of muriatic acid for cleansing, and its action on the metal, v. 214, 215.

Breakwater commenced at Madras, ii. (1842) 127.

Buoys, and floating light-ships, and manner of mooring them, xv. 10.—Buoys and floating beacons, xx. 309.—Buoys used on Lake St. Peter, in Canada, 311.

Electric telegraph. Telegraph wires enveloped in Trinidad pitch, xi. 883.

Foundations. Mitchell's screw-piles, ix. 187.—Potts' system, 187.

GORE.

Lighthouses, revolving lenses in, i. (1840) 24.—Origin of cast-iron lighthouses, ix. 186.—System of building them with a core of masonry, or concrete, for some height above the base, 187.—Objections to an open frame-work structure on the Bishop Rock, 187.—Trials of Mitchell's screw-piles, and Potts' system of sinking a foundation for, 187.—Preservation and expenditure of stores in lighthouses, 188.—Bulwer's lighthouse built on the Edystone rock in 1708, 189.

Lights, reflectors for, xv. 24.

Mines, ventilation of, steam-jet as a means for the, x. 53.—As to terms 'choke-damp,' 'fire-damp,' and 'after-damp,' xii. 297.—Age of Cornish miners, 309.

Patent slip, improvements in the, proposed by Captain Brown, ii. (1842) 137.

Photography. "Photography as applicable to engineering," i. (1840) 57.

Ships, measurement of, for tonnage, xiii. 62.

Steam-boilers, explosion of, xi. 399.

Timber, relative value of different kinds of, in the construction of ships, viii. 269.

Tower of St. Rombaut, at Mechlin, x. 242.

GORDON, Captain, R.N.

Lights, floating. As to light-ships parting from their moorings, xv. 16.—Proposed circular wrought-iron sea-light tower, 21.

GORDON, Colonel J. W., R.E. [Election, xvi. 226.]

GORDON, D.

Gas. Reference to his compressed gas, xvi. 309.

GORDON, Professor L. D. B.

Drainage of towns. Extracts from his description of Captain Vetch's plans for the sewerage of the metropolis, as proposed in February, 1859 (Harrison, J. T.), xiii. 74.

Turbines. "Remarks on machines recipient of water power, more particularly the turbine of Fourneyron," ii. (1842) 92.

Gordon's (Prof.) horizontal half-lap joints for railway bars, xi. 260.

GORE, H.

Gas, use of clay retorts for making, de-

'GORGON' STEAM FRIGATE.

scription of fuel, apparatus employed in the process of carbonizing, and mode of setting the retorts, xvi. 315.—Leakage of gas through mains, 319.

'Gorgon,' H.M. steam frigate, description of the engines of, i. (1841) 53.

GOSAGE, W. [Election, i. (1841) 63.]

GOUGH, N. [Election, iv. 63; memoir, xiv. 152.]

GOVIN, E.

Engines. His report on the performances of Du Trembley's combined vapour engines, as fitted in the ship 'Brésil,' xviii. 237.

Government interference with engineering works, vi. 28, 184, 187, 188, 191, 196, 203, 204, 206, 209; vii. 30; viii. 134; x. 62; xv. 237.

— works, the progress of, and those undertaken by private enterprise contrasted, illustrated by reference to the New Westminster bridge, and the bridge over the river St. Lawrence, at Montreal, xix. 227.

GOVERNORS.

Chronometric. Description and drawing of a chronometric governor invented by Messrs. E. W. and C. W. Siemens (Woods, J.), v. 255.—The disadvantages of Watt's and other centrifugal governors noticed, 255.—Ditto of Hicks's fly and screw governor, 256.—Description of the chronometric governor, 256.—Its advantages, 257.—Modification of the principle to water-wheels, &c., 258.—Calculation of the error of the pendulum, under certain conditions, 258.—Description of a variable expansion, or revolving slide valve, invented by Messrs. Siemens, 259.—Mode of regulating the closing of a shut-off steam-valve which is opened by the engine in the usual manner, 260.

Discussion. — Amos, C. E., 265.—Carpenter, H., 262.—Davison, R., 265.—Field, J., 263.—Muy, C., 265.—Stephenson, R., 261.—Thorold, W., 264.—Woods, J., 261, 264.

First application to machinery (Rennie, Sir J.), v. 53.

Fly-vane (Smith, T.), xvii. 367.

GRANTHAM.

Gow, J. [Election, ii. (1842) 138; resignation, x. 72.]

GRADIENTS.

London, of some of the principal thoroughfares of, (Turner, J.), ii. (1842) 71.

"Table of gradients." By C. Bourns, i. (1838) 49.

Vide also RAILWAY INCLINES, and RAILWAYS.

GRAFTON, —.

Gas, fire-clay retorts for making, and opinion of Mr. S. Clegg, Jun. thereon (Church, J.), xvi. 309.

GRAHAM, J. [Election, xvi. 371.]

GRAHAM, Professor.

Gas. Purification of coal-gas, iii. 302.

Water from chalk wells in London, presence of carbonate of soda in, and difference in chalk waters, viii. 174.

GRAHAM, R. W. [Election, xvi. 226.]

GRAINGER, T. [Memoir, xii. 159.]

Granite, found in a decomposed state in mines, and called 'Potgrawen,' iii. 150.—Constitutes the 'Kaolin' of China, 150.—Found in the Andes, in such a decomposed state as to be unsafe for the sides of cuttings, 152.

—, artificial, xi. 490.

GRANT, C. H. [Election, xvi. 226.]

GRANT, W. T. [Election, ii. (1843) 134.]

GRANTHAM, J. [Election, i. (1840) 18.]

Naval construction, &c.. References to his work, "Iron as a material for ship-building" (Wilkinson, J. J.), ii. (1842) 168; (Manby, C.), ii. (1843) 180.

Screw-propeller. "Account of some experiments on a vessel called the 'Liverpool Screw,' fitted with Grantham's engines and Woodcroft's screw-propeller," iii. 71.—Remarks, 82, 85.—Screw-propellers, 82, 85.—Changes in the cast-iron propeller of the 'Napoleon,' 85.

Steam-engines. "On the stationary engines at the new tunnel on the Liverpool and Manchester railway," i. (1841) 146.

Steam-vessels. "Description of the 'Vanguard,' iron steam-vessel, after being ashore on the rocks in the Cove of Cork," iv. 302.

— "Description of the 'Sarah Sands,'

GRANTHAM.

and other steam-vessels, fitted with direct-acting engines and screw-propellers without intermediate gearing," vi. 283.—Remarks, 289.—Movement of the screw-propeller on board the 'Diamond,' 289.—Second voyage of the 'Sarah Sands,' 290.—Best form for the screw-propeller, 296.

GRANTHAM, R. B. [Election, iii. 342; Telford premium, ix. 95; Auditor, xiv. 96; xv. 75; Telford medal, xx. 121, 170.]

Abattoirs. "Description of the abattoirs of Paris," viii. 66.—Remarks, 80.—Proposed establishment of public slaughter-houses, 80.—Modes proposed for remedying the evil of connecting offensive trades with the slaughter-houses, 81.

Drainage of land. "On arterial drainage and outfalls," xix. 53.—Remarks, 122.—General principles to be adopted in carrying out such works, 122.—Want of legislation a great impediment to land-drainage upon a large scale, 123.—Pipe-drainage, and the depth to which it should be carried, 124.—Under-drainage of land, xx. 228.

Steam navigation. Homeward passage of the 'Sarah Sands,' vi. 293.

Surveying instruments. Clinometer, v. 480.

Weirs, oblique, effect of, on the river Shannon, v. 360.

GRAVATT, W.

Bridges. Cause of sinking of one of the arches of Maidenhead bridge, x. 235.—Smeaton's practice of making every third, or fifth, pier in a long bridge, an abutment, x. 240.

Calculating machine, Scheutz', xvi. 225.—Specimens of tables calculated, stereomoulded, and printed by machinery, 421.

Canal incline-planes, xiii. 209.

Cements, adhesion and setting power of, xi. 504.—Experiments at the Thames tunnel, 504.

Engines, friction of, ii. (1843) 73.

Horse-power, ii. (1843) 115.

Iron, effects of vibration on the fibres of, ii. (1843) 93.

GREAT EXHIBITION, 1851.

Light, experiments upon, vi. 387.

Railway curves, setting out, ii. (1843) 109.

Steam, effect of cooling upon high-pressure, vi. 339.

Telegraph cables. Velocity of, and form assumed by, a telegraph cable in falling through the water, with reference particularly to the Atlantic cable, and the strains to which it would be subject in sinking, xvii. 322.—As to breaking the fall, or lessening the strain on the cable, by means of floats, 324.

Thames tunnel, account of the fracture of the 'fleeing bars' used at the, ii. (1843) 93.

Water, gases produced by the decomposition of, xvi. 419.

Weirs, effect of the, in the river Severn, v. 359.

Gravel buttresses in the slopes of railway cuttings, iii. 144, 160.

Gravesend, cast-iron new pier (Rodman, J. B.), iv. 222.

Graving dock, substitute for, (Mallet, R.), ii. (1842) 135.

GRAY, Dr. J. E.

Decimal coinage, &c. Difficulty of introducing uniformity into certain of the more common measures of capacity, shown by a late return, whence it appeared that wheat was still sold, in almost every market, by a different measure, xiii. 313.—Tardiness in adopting the French metrical system, 315.—Difficulties in introducing a decimal system of coinage into England, 315.—What would be required to bring the French system of coinage into use in this country, 316.

GRAY, Messrs.

Fire-proof buildings. Fall of their cotton-mill at Manchester (Fairbairn, W.), vi. 213.

'Great Britain' iron steam-ship, description of, and account of her trial voyages, (Guppy, T. R.), iv. 151.

Great Exhibition of the works of industry of all nations in 1851, on the construction of the building for, (Wyatt, M. D.), x. 127.

———, allusions to, xi. 85, 147, 149.

GREAVES.

- GREAVES, C.** [Election, vii. 326.]
 Bells at the New Palace, Westminster, xix. 15.
 Cement, expansion of Portland, xvi. 443.
 Concrete, as used in this country and at Rome, xvi. 440.
 Drainage of towns. Stanley Green liquid sewage works, xx. 247.
 Engines. Combined vapour engine contrasted with ordinary marine engine, and division of engines into three classes, in respect to load, Cornish, factory and marine, xviii. 268.
 Ferries. Floating ferries, or bridges, at Portsmouth and at Calcutta, and their comparison with the steam-ferry over the river Nile, at Kaffre Azzayat, xvii. 63.
 — Ditto at Portsmouth and at Torpoint, xx. 386. — Floating railways across the Forth and Tay ferries, 389.
 Fuel, progress in the economy of, especially in stationary engines, and production of smoke, xix. 581.—Amount of small coal and gas coke employed in four sets of boilers, and evaporative power per lb., 582.—Relative calorific power of coal and coke, 582.
 Isthmus of Suez. Difficulties of the navigation of the Red Sea and the Mediterranean at the outlet of the proposed canal, x. 379.
 Public works in India, difficulties experienced in carrying out, xvii. 523.—Remains of ancient works in Bengal, particularly a road called the 'Peepul putter ka Seran,' 523.
 Rivers. Embankments of the river Damooda, and its liability to violent floods, xvii. 523.
 Smoke-prevention apparatus, xiv. 16, 17.
 Steam-engines. Advantages of a steam-jacket round the cylinder, xviii. 269.—Expansion, 270.—Use of meters to test the efficiency by the quantity of water used, 270.—Expansion curves developed in the Cornish pumping engine, and in ordinary marine engines, 287.—Increase of pressure required in the initial steam, to create a stroke of the original value, when working expansively, 288.—Circumstances under

GREEN.

- which super-heating steam, or clothing and jacketing the steam passages, would be advantageous, xix. 482.
 Water-meters, xvi. 56.
 Water supply, rainfall, the rate of evaporation, the quantity of water issuing out in the rivers, and delivered by springs, xvii. 522.—Amount of evaporation from the surface of land, and rain-gauge observations, xviii. 391.
GREAVES, H.
 Permanent way. Use of fish-plates prior to the year 1838, on the Camden and Amboy railway, U.S., xvi. 292.—Cost of surface-packed, cast-iron sleepers, and of ordinary creosoted timber sleepers, xviii. 435.
 Greaves' (H.) iron sleepers, remarks as to, xi. 252, 279, 284; xvi. 245.—Method of expediting the laying of the permanent way, when using ditto, as practised in Egypt, 381.
 —, with Douglas' fish-joint chair, xi. 253.
 — joints and fastenings, xvi. 241.
 Greaves' blue lias lime, ix. 233.
GREEN, B. [Telford medal, ii. (1842) 7.]
 Bricks, ornamental, for architectural purposes, iii. 112.
 Bridge, proposed, over the Tyne, at Newcastle, iii. 112.
 Viaducts. "Description of the arched timber viaducts on the Newcastle and North Shields railway, erected from the designs of Messrs. John and Benjamin Green, and on the application of the same system of construction to oblique and other bridges, to the roofs of railway stations, and to other large buildings," i. (1841) 88; v. 219.
GREEN, G.
 Machinery for the manufacture of casks, particularly the stave-sawing and backing machines, xvii. 44.—Best form for the teeth of saws, 46.
 Green's method of insuring accuracy of variable bevil, in the saw for cutting ship-timber, in curved forms, xvii. 25.—Ditto of backing and hollowing, in the manufacture of casks by machinery, 38.

GREEN.

GREEN, JAMES. [Telford medal, i. (1839) 9; Telford premium, viii. 6; memoir, ix. 98.]

Canals. "The canal lifts on the Grand Western canal," i. (1838) 28.—Remarks, 28.

—, Exeter. "Continuation of the memoir of the canal of Exeter, from 1819 to 1830," iv. 102.—Summary of reports on ditto, from 1820 to 1826, 106.—Remarks, 111.

Drainage of towns. "Account of the recent improvements in the drainage and sewerage of Bristol," vii. 76.—Remarks, 87.—Main object of the works, 87.

Piles, driving, iii. 200.

Railway cuttings, &c., causes of slips in, iii. 169, 171.

Rivers and estuaries. Changes in the estuaries of the Exe, the Axe, and the Sid, from the action and movement of shingle, and of the material forming the coast, vii. 360.

Sea-defences. Dymchurch wall, or embankment, its construction and dimensions, and the repairs and reconstruction executed after the damage done by the sea in 1803, vii. 194.

GREEN, JOHN. [Election, i. (1840) 18; memoir, xiii. 138.]

Viaducts, arched timber. *Vide* GREEN, B.

GREENER, W. [Election, i. (1841) 129; resignation, iv. 184.]

Artillery, ii. (1843) 107.

Fire arms. Experiments upon gun-barrels, ii. (1843) 107.

Greenwich Hospital, distribution of fire-plugs and water-pipes, iii. 329.

GREENWOOD, T. [Election, xx. 106.]

GREGORY, C. H. [Election, i. (1838) 9; Telford medal, iv. 3; Member of Council, viii. 44; ix. 91; x. 60; xi. 84; xii. 112; xiii. 128; xiv. 97; xy. 76; xvi. 88; xvii. 70; xviii. 164; Vice President, xix. 182; xx. 108.]

Artillery. Method of casting ordnance in the United States, xviii. 841.—Construction of artillery, as introduced by Capt. Blakely, Mr. Longridge, Sir William Armstrong, Mr. Mallet, Mr.

GREGORY.

Lancaster, and Mr. Whitworth, and as to the Ordinance Select Committee, xix. 344.

Bridges, suspension, testing the bars for, viii. 277.

Electric telegraph, importance of the, in promoting the economy of railway working, xi. 465.

Exhibition in 1851, first proposal for making the building like a large conservatory, due to Mr. W. B. Adams, x. 191.

Locomotive boilers, explosions of, xv. 301.

Locomotive engines. "Practical observations on the management of a locomotive engine," i. (1841) 73.

Permanent way. As to 'fishing' the joints of rails, ix. 405.—Materials best suited for permanent way in India and similar countries, xviii. 425.—Mr. W. B. Adams' system of enabling the double-headed rail to be used without chairs, 426.—Different varieties of iron permanent way, xx. 277.

Railway, atmospheric. Series of experiments on the working of the system at Dalkey, iv. 145.

Railway cuttings and embankments.

"On railway cuttings and embankments, with an account of some slips in the London clay, on the line of the London and Croydon railway," iii. 135.—Remarks, 148.—Railway cuttings and slips, 148, 150.

Railway signals. Maroons used as signals on the Croydon railway, i. (1841) 116.

Railways. Notice of a self-acting siding stop for railways, x. 192.—Importance of dividing heavy trains, xi. 465.—Uniformity of parts of railway stock, 465.—Extent to which railway companies should manufacture their own stock, 466.—Proposed territorial division of railway system, 466.—Construction of the engines and carriages used on railways in the United States, and cost of construction of railways in the States of Massachusetts and New York, xviii. 66.

Roofs. Galvanized iron covering of roof at Bristol station, xiv. 266.

Telegraph cables. Mode of construction

GREGORY.

- of a submarine telegraph cable, xvii. 301.
- Tunnels, cost and manner of executing, for railways and canals in the United Kingdom, compared with those on the proposed route, by the Valley of the Atrato, for effecting a junction between the Atlantic and Pacific oceans, xv. 405.
- Viaducts, construction of, x. 301.
- GREGORY, Dr. [Memoir, ii. (1842) 12.]
- GRÈVE, A. [Election, ii. (1843) 155; memoir, xviii. 190.]
- GREW, N. [Election, xix. 461.]
- Gridiron, for repairing vessels, at Liverpool, Havre, &c. ii. (1842) 137.
- GRIFFITH, R. [Election, i. (1839) 72.]
- GRIFFITH, R.
- Naval construction. The form of a ship should be suitable to the power intended to be applied, as shown in the trials of the 'Flying Fish,' xvi. 344.
- Screw-propeller, resistance offered by the water to the blades of a, xvi. 345.
- Griffiths' work on 'Naval Architecture,' quotation from, relative to the steamship 'Georgia,' one of the largest American ocean steamers, xiii. 59.
- Grimsby docks, coffer-dam at, (Neate, C.), ix. 1.
- GRISSELL, H. [Election, ii. (1843) 105.]
- Girders, strength of, xiii. 471.
- GRISSELL, T. [Election, i. (1839) 44; Telford medal, iv. 3; Member of Council, iv. 62.]
- Brick-raising machine, Journet's, iii. 222.
- Bridges, comparative cost of iron and timber, iii. 60.—Yarmouth suspension bridge, iv. 296.
- Rivers. Removal of the marl shoals in the river Severn, iv. 371.
- Scaffolding. "Account of the scaffolding used in erecting the 'Nelson column,' Trafalgar Square," iii. 203.—Remarks, 207.
- GRÖVENOR, Lord ROBERT.
- Drainage of towns. Flushing sewers, and utilizing the sewage for agricultural purposes, vii. 86.
- GROVE, E. [Election, x. 57.]
- GROVE, G. [Election, i. (1839) 44; resignation, x. 72.]

GUPPY.

- GROVE, W. R.
- Electro-magnetism as a motive power, and its cost, xvi. 402.—Theoretical difficulty of the equivalents of power, 403.—Improvement of the prime mover—the battery—or the economical mode of charging it, 404.
- Engines. Relative merits of the ether, or combined engine, and of the ordinary steam-engine, xviii. 259.
- Groyne, construction of, vi. 99, 144.—Warping by means of, 143, 148.—Use of ditto as shore defences, 144.
- for constructing the new docks at Sunderland (Brown, W.), viii. 186; (Murray, J.), xv. 421.
- along the south coast of England, xi. 162.
- protecting embankment in the Malahide Estuary, xiv. 248.
- *Vide also COASTS and SEA DEFENCES.*
- GRUNDY, R. [Election, xiii. 421; memoir, xx. 140.]
- GUÉRIN, E.
- Railway breaks. "On railway breaks," xvii. 153.—Remarks, 169.—Cost of applying his system, 169.
- Guerin's self-acting railway break, xix. 491.
- GUEST, Sir J. J., Bart. [Member of Council, i. (1841) 52; memoir, xii. 163.]
- Gun-barrels, experiments upon the expansion of, in firing, ii. (1843) 107.
- Gun-cotton, vi. 26.
- Gun metal, composition of, iii. 88.
- GUNN, J. C. [Election, ix. 57.]
- Gunnery, modern improvements in, and in the application of steam power to propulsion, changes which, have produced, xx. 396. *Vide also DEFENCES, NATIONAL.*
- Gunpowder, experiments as to the ultimate force of, xix. 286, *et seq.*—Lieut. Rodman's perforated cake, xx. 414. *Vide also ARTILLERY.*
- Guns. *Vide ARTILLERY.*
- GUPPY, T. B. [Election, ii. (1842) 138.]
- Naval construction, &c. Strength of iron vessels, as instanced by the 'Vanguard' and 'Great Britain,' iv. 306.

GURNEY.

Steam-vessels. "Description of the 'Great Britain,' iron steam-ship; with an account of the trial voyages," iv. 151.—Remarks, 166.—State of the engines, &c., during her voyage from Bristol to London, January, 1845, 166.—The driving machinery, 169.—Means of disconnecting the screw-propeller, 176.

GURNEY, G.

Air-engines. Expansion of aëriform bodies, and their use as a motive power, ix. 198.—The use of heated air as a motive power, xii. 332.—Destruction of the heating vessel is the principal difficulty, 338.—Using economically the power of air expanded by heat, 338.

Bude light, ii. (1843) 189.

GYPSUM.

Gas. Atmospheric gas-burner, ii. (1843) 190.

Mines, steam jet for the ventilation of, x. 51, 53, 54.—Extinguishing a fire in the South Sauchie colliery, near Alloa, by pouring in choke-damp, 53.

Gutta percha, xii. 457, *et seq.*—Non-conducting qualities of, and its fitness for insulating telegraph wires, xvi. 189.—Decay of, xvii. 315.

GUY, H. [Premium, i. (1839) 11.]

Balls of metal, glass, agate, or other hard substances, method of giving a true spherical figure to, (Donkin, B.), i. (1837) 22.

GWYN, H. [Election, x. 57; resignation, xiii. 134.]

GWYNNE, J. E. A. [Election, xv. 246.]

Gypsum, used as manure, ii. (1842) 68.

H.

HAARLEM LAKE.

Haarlem lake extends over 45,000 acres, ii. (1842) 173.—Drainage of, commenced, 173.

HACK, W. B.

Water-works. Method of laying the lines of water-pipes between Twickenham and Richmond, crossing the river Thames, xiv. 37.

Hackworth's locomotive engine, the "Sans Pareil," v. 73.

HADDAN, J. C.

Artillery, construction of, and results obtained by rifling the existing service gun, and by using particular projectiles, xix. 361.

Patent laws. Provisional protection for six months, to enable inventions to be shown at the Great Exhibition of 1851, x. 218.

HADEN, G. [Memoir, xvi. 124.]

Hæmatite ore, ii. (1843) 82. *Vide also* IRON.

HAGUE, J. [Election, i. (1838) 41.]

Iron ores. Report on smelting the hæmatite iron ores of Semakoff, iii. 229.

Hainault Forest, reclamation of, by underground and arterial drainage, xix. 78. *Vide also* DRAINAGE.

HAKKILL, P. H.

Well at Hampstead water-works, xiv. 74.

HALL, Captain B.

Lighthouses, lighting of, i. (1840) 20; (Annual Report), i. (1841) 12.

HALL, Dr. MARSHALL.

Carbonic acid. His opinion on the poisonous action of carbonic acid on the function of respiration, and the circulation of the blood (Faraday, Professor), ii. (1843) 190, 191.

HALL, J. [Election, ii. (1843) 105.]

HALL, R. [Election, xx. 258.]

HALL, R. B.

Steam-boilers, explosions of. Relative influence of internal flue-firing and under-firing in causing, xv. 202.

HALL, S. [Election, ii. (1843) 184.]

HALY.

HALL, W. [Election, xviii. 72.]

Railway ferries. "On the floating railways across the Forth and Tay ferries, in connection with the Edinburgh, Perth, and Dundee railway," xx. 376.—Remarks, 388.

HALL, W. B. [Election, xvi. 226.]

HALL, W. K. [Council premium, xvi. 93.]

Machinery, use of self-acting, xv. 306.

Steam. Spheroidal state assumed by water, xv. 306.—Properties of surcharged steam, 307.

Steam-boilers, explosions of. "On the causes of the explosions of steam-boilers," xv. 281.—Remarks, 286.—Experiments with water-blow-off valve 286.—Causes of recent explosions, 305.

Hall's apparatus for working railway breaks, xviii. 70.

—system of moveable fire-bars for smoke-consuming, xiii. 391, 406.

HALSTED, Captain, R.N.

Buoys, beacons, sea-lights, &c. Principle of mooring, or attaching vessels, or other floating bodies, from their centre of gravity, instead of from the bows, xv. 18.—Form of proposed circular wrought-iron sea-light tower, 19.—Fairway, or guiding lights, for the entrances of wide channels, 20.—The 'Owers' light between the Thames and Spithead, 23.

Steam navigation, &c. The true principles of combination of sails with steam as an auxiliary power, xiv. 400.—Fleet belonging to General Screw Steam Shipping Company, 400.—Means of lifting screw out of water, 402.—Best proportions of steam power to tonnage, 402.

Wrecks on British coasts, xv. 20.

HALY, W. T.

Drainage of towns. The contents of sewers not of a fertilizing character, xx. 240.—Sewage works at Leicester, 241.—Liquid sewage works at

HAMBURG.

- Stanley Green, 242.—Application of liquid sewage at Croydon, and at the Earl of Essex' home farm at Cashio-bury, Watford, 243.—Irrigation with sewage water of the Craigentenny meadows, Edinburgh, 243.—Effect of the system upon the health of the district, 244.—Ditto of the open liquid sewage irrigation of the land around Milan, 244.—Reports of Messrs. Galton, Simpson, and Blackwell, and of Messrs. Bidder and Hawksley, as to the utilization of liquid sewage, 245.
- Hamburg, sewerage of, as carried out by Mr. W. Lindley, xiii. 78, *et seq.*
- HAMILL, E. D. [Election, xx. 106.]
- HAMILTON, J., Jun. [Election, xv. 246.]
- HAMILTON, R. W. [Election, iv. 186.]
- Hamilton's saw, for cutting ship-timber, in curved forms, xvii. 25.
- HANCOX, J. [Election, xx. 191.]
- HANDCOCK, Captain E. R.
- Railway axles. "Description of an improved form of the journals of the axles for railways," ii. (1843) 166.—Remarks, 167.—Consumption of oil by axles, 167.
- HANDLEY, H. [Election, i. (1838) 26; memoir, vi. 5.]
- HANDYSIDE, W. [Election, i. (1838) 12; resignation, x. 72.]
- HANDYSIDE, W. [Memoir, x. 85.]
- Fire-proof buildings. Construction of the Government Paper Office at St. Petersburg, vi. 221.—Ditto Winter Palace at St. Petersburg, 221.—Saw-mill with fire-proof floors, 223.
- HANKEY, W. A. [Treasurer, i. (1837) 15; (1838) 20; (1839) 27; (1840) 36; (1841) 52; ii. (1842) 51; (1843) 56; iii. 57; memoir, xx. 134.]
- HANN, J. [Election, ii. (1843) 183; resignation, xiii. 134.]
- Mines, natural brattice, in the shafts of, x. 52.
- HANSON, J. F. [Election, i. (1839) 80.]
- Hanson and Chadwick's water-meter, xiii. 427.
- HANVEY, J. [Election, x. 57.]
- HARBOURS.
- Arbroath, trenails used in the stones of the walls, ii. (1842) 147.

HARBOURS.

- Banff, (Bremner, J.), iii. 123.—Casks used at, for floating large stones, 123.
- Belfast. "On the velocity of water in Belfast harbour." By W. Bald, i. (1837) 37.
- Construction of, (Rennie, Sir J.), v. 37.—Review of this branch of engineering, from the time of Smeaton, 37.—Means adopted to improve several natural harbours, 39.—Treatment of bar harbours, vi. 22.—Construction of artificial harbours, 24.—Construction and maintenance of, in a travelling beach, (Bidder, G. P.), xii. 548; (Rennie, Sir J.), 549.—Necessity for making, of such dimensions as to accommodate vessels of increased size, (Rendel, J. M.), xiii. 61.
- Dundee, (Leslie, J.), i. (1840) 10.
- Floating breakwaters, for protecting the entrance to a, on the north-western coast of Holland, (Croker, B. W.), xv. 23.
- Folkestone (Palmer, H. R.), ii. (1842) 129.
- Harwich, alterations in the coast line at the entrance of, and hydrological history of the locality, (Curtis, J. G. C.), xx. 21.—Progressive increase of Land-guard Point from 1804 to 1859, 23.
- Italian, (Rennie, Sir J.), iv. 322.
- Kingstown, diving-bell used at, (Henderson, P.), ii. (1842) 148.—Area of, and length of piers, 149.—The formation of, by Smeaton (Rennie, Sir J.), v. 38.
- Lowestoft (Bidder, G. P.), vi. 158; (Rendel, J. M.), xi. 157; (Bidder, G. P.), xii. 548.
- Newhaven, (Hood, Capt.), xii. 15.—Extracts from reports of Yarranton, in 1677; of Collins, in 1698; of the Commissioners on the Harbours of the South-Eastern coast, in 1840; of the Harbours of Refuge Commissioners, in 1844; of Mr. Walker, in 1843 and in 1846; and of others, relative to, 15.—Success of the works executed at, (Russell, J. S.), 17.
- Nieuwediep, at the Texel roads (Jackson, G. B. W.), vi. 104.—Description of the locality, 104.—The shore-works, 105.—Rise of the tide at

HARBOURS.

various places along the coast, 105.—Commission appointed to decide on the best position for the harbour, &c., 105.—The breakwater, 106.—The warping bank, 106.—Effects of these two works, 107.—Erection of a quay-wall, and a jetty of timber-framing, 107.—Dredging operations, 108.—The locks or entrance to the docks, 108.

Ostia. "On the ancient harbour of Ostia." By Sir J. Rennie, iv. 307.—On the situation of Ostia, 307.—The geographical and geological features of the valley of the river Tiber, 307.—The works at the mouth of the Tiber, where it falls into the Mediterranean Sea, 308.—The port of the emperor Claudius, 309.—Means adopted for removing the bar at the mouth of the Tiber, 312.—On the application of dredging-machines for such purposes in modern days, 312.—Means adopted to render the Tiber navigable from its mouth to Rome, 313.—The construction of a new port at Centum Cellas, 315.—The principles adopted, 317.—General results, 319.

Discussion.—Giles, F., 320.—Rennie, Sir J., 321.—Thorold, W., 323.

Port Talbot. "Description of the harbour of Port Talbot (Glamorganshire)." By H. R. Palmer, ii. (1843) 188.

Pulteney-Town. "Account of the town and harbour of Pulteney-Town (Wick, Caithness), from their origin in 1803 to the year 1844." By J. Bremner, iii. 115.—Description of the works, 115.—Causes of the accumulation of sand, 115.—Rise of the tide, 117.—Forms of quay-walls, 117.—Crane barges used in the construction, 119.—Partial destruction of the works, 119.—Causes of the failure, 119.

Ramsgate. (Rennie, Sir J.), v. 37.

Sites for, selection of, xv. 453, *et seq.*

Sunderland. (Murray, J.), iii. 343. *Vide also* DOCKS, Sunderland; and RIVER WEAR.

Swansea. (Palmer, H. R.), ii. (1842) 129.

HARBOURS.

Terneuse harbour and canal (Cubitt, Sir W.), vi. 113.

West Hartlepool. (Simpson, J.), vi. 145, 146.—Description of a raft, or float, used for submarine blasting, on the works of the, (Casebourne, T.), x. 293. *Vide also* BREAKWATERS, COASTS, HARBOURS OF REFUGE, and PIERS.

Harbours and rivers, causes in constant operation tending to alter the outline of the English coast, to affect the entrances of the, and to form shoals and deeps in the bed of the sea, (Harrison, J. T.), vii. 327. *Vide also* COASTS.

HARBOURS OF REFUGE.

East coast of England, necessity for, (Simpson, J.), vi. 145.—Situations for, xx. 354, *et seq.*

Financial system adopted, and principle of construction employed, at Dover, Alderney, Jersey, Holyhead, and Portland, (Bidder, G. P.), xix. 225.

National defences, harbours of refuge viewed in relation to the, as bases of operations for the navy, (Bidder, G. P.), xix. 225.

North Sea, necessity for, in the, (Bidder, G. P.), xx. 374.

Sites for, and construction of. "On harbours of refuge." By the Right Hon. the Earl of Lovelace, vii. 366.—Report from the Select Committee of the House of Commons, in 1836, as to the causes of shipwreck, 366.—Committee of the House of Commons appointed in 1843, to inquire into the subject of harbours of refuge, 367.—Opinion of the Duke of Wellington as to the effect a war with France would have, on the trade passing the coast of Kent, 367.—Two separate objects to be accomplished, safety from the weather, and defence against the enemy, 368.—Floating breakwaters proposed for the former purpose, 368.—Plan suggested by Captain Taylor, 369.—Ditto, Captain Pringle, R.E., 369.—Ditto, Captain Sleigh, R.N., 369.—Ditto, Major Parby, B.E., 369.—Commission appointed in 1844, to report whether a harbour of refuge in the Channel is desirable,

HARBOURS.

and what should be its site, 370.—Recommendations in the Report, 371.—Three sorts of harbours described, 371.—Disadvantages of an open harbour, covered by a breakwater unconnected with the shore, 372.—Captain Vetch's proposal to utilize the open roadstead of the Downs, by fixing the Brake and the Goodwin Sands, 372.—Sir John Rennie's idea of enclosing the small Downs, by artificially increasing the Brake, 373.—Breakwater at Portland recommended by the Commissioners, 373.—Result of the inquiry instituted by the Commissioners, the construction of a breakwater at Dover, examined, 374.—Evils to be apprehended at Dover, the accumulation of shingle to the westward, and the general deposit of silt, 375.—Opinions of Captain Vetch and Sir H. De la Beche, 376.—Dungeness affords an illustration of the views of the latter, 376.—Pier or breakwater, projecting from the shore at Dover, will probably form a sort of Ness, 377.—Obstacles presented by the silt considered, and opinions of Captain Vetch and Sir H. De la Beche, 378.—Captain Vetch's proposed plan for an insulated breakwater, 378.—Prof. Airy on the probabilities of silting up, under the different conditions of a through current and a single entrance, 378.—Captain Washington's experiments on the quantity of silt held in solution by the water in Dover Bay, 379.—The expense of dredging, 380.—Question of construction considered, 380.—Cherbourg breakwater, 381.—Mr. Rendel's objections to the Plymouth breakwater, 381.—Arguments in favour of the long slope, deduced from the harbours of Kingstown, Howth, Ardglass, Donaghadee, Portrush, and Dunmore, 381.—Plymouth breakwater, 383.—Permanency of a long slope depends upon its being constantly supplied with a succession of materials, 384.—Captain (now Sir William) Denison, R.E., on the best form and materials for the construction

HARDING.

of a breakwater, 385.—Mr. Hartley as to the action of the sea on an upright wall, 386.—Captain Vetch ditto, 387.—Prof. Airy ditto, 387.—Sir W. Symond's views against making a harbour of refuge at Dover, 389.—Sir Howard Douglas' reasons for disagreeing with the recommendations of his colleagues, 389.—Sir H. De la Beche on the action of the sea on coasts, 390.—As to Cherbourg serving to demonstrate the superiority of the principle of the slope, 391.—Mr. Stuart's objections to the solid body in the middle, as at Cherbourg, 391.—Theories of Colonel Emy, especially in his book '*Du Mouvement des Ondes*,' and his advocacy of long slopes of rubble, 392.—Emy's theory of the '*flot du fond*,' 394.—Bremontier and La Coudraye's ideas as to the action of waves, 394.—Mr. Alan Stevenson's marine dynamometer for testing the force of the waves, 395.

Discussion.—Lovelace, Earl of, 410.—Murray, J., 411, 414.—Pasley, Lieut.-Gen. Sir C. W., 411, 414.—Rendel, J. M., 409.—Rennie, Sir J., 402, 414.—Russell, J. S., 414.—Walker, J., 398, 415.

Vide BREAKWATERS, HARBOURS, and PIERS.

HARDIE, T. G. [Election, i. (1838) 12; Telford premium, ii. (1843) 6; resignation, x. 72.]

Iron-works. "Description of the mill, forge, and furnaces of a Welsh iron-work," ii. (1842) 60.

HARDING, W. [Election, v. 248; Telford medal and Council premium, vi. 2; Member of Council, viii. 44; memoir, xv. 97.]

Fluids, elastic. Law of the discharge of air into a partial vacuum, vi. 385.—Difference between the law of elastic fluids propounded by Mr. Froude and that hitherto assumed to be correct, 392.

Fuel. Duty performed by different fuels, viii. 112.

Gas, saving by the use of naphthalized, viii. 231.

HARGRAVES.

Permanent way of the Dublin and Drogheda railway, viii. 270.

Railway companies, impolicy of becoming manufacturers, xi. 464.

Railway inclines. Mode of working inclined planes, particularly the Oldham incline, x. 250.—Good gradients relatively of less importance on passenger than on mineral lines, 255.

Railway stations, cost of portorage in, and of storing goods, viii. 177, 180.

Railway trains, resistances to. "On the resistances to railway trains at different velocities," v. 369.—Remarks, 411.—Resistances to a train of certain weight and velocity, travelling towards Forest Hill, on the Croydon railway, 414.—Mode of measuring the resistances, 415.—Mr. D. Gooch's experiments and evidence before the Gauge Commissioners, 417.—As to taking the steam used in the locomotive, as a measure of resistance, and further remarks on Mr. Gooch's experiments, 424.—Mode of calculating the effect of the steam in one of his experiments, and further remarks on Mr. D. Gooch's experiments, 430.—Deductions from the experiments, 432.

—, and mode of conducting experiments for ascertaining the, vii. 295, 308, 326.—Ditto, and as to experiments on inclined planes, 315.—Report of the Gauge Commissioners, 322.

Railways, cost of, and the expenses incurred after opening, viii. 180.—Railway management and fares, xi. 461.—Economy of railways, 469.

HARGRAVES, —.

Gold. Extract from 'Account of his Adventures in California' (Hopkins, E.), xv. 71.

HARLEY, —.

Water supply. His speculation for supplying water to Glasgow (Mackain, D.), ii. (1843) 134.

HARMAN, H. W. [Election, x. 57.]

HARRATT, C. [Election, v. 340.]

HARRIS, G. W. [Election, vii. 184.]

HARRIS, J. [Election, i. (1840) 50.]

Bridges. "Description of a stone bridge

HARRISON.

on the Middlesborough railway," i. (1841) 138.

Permanent way, particularly the chairs and rails, v. 242.

HARRIS, S.

Carbonic acid, poisonous action of, ii. (1843) 190.

HARRISON, G. [Election, vii. 75; resignation xv. 85.]

HARRISON, G. [Election, xi. 478.]

HARRISON, H. [Election, xvii. 483.]

HARRISON, J.

Levelling machine. "Description of a proposed levelling machine," i. (1837) 35. Scaffolding, iii. 207.

HARRISON, J. [Election, xvi. 371.]

HARRISON, J. A. [Election, xviii. 296.]

HARRISON, J. T. [Election, vi. 218; Telford medal and Council premium, viii. 5; ix. 95; Council premium, xiv. 105.]

Coasts, &c. "Observations on the causes that are in constant operation tending to alter the outline of the English coast, to affect the entrances of the rivers and harbours, and to form shoals and deeps in the bed of the sea," vii. 327.—Remarks, 361.—The island in front of the Warren, 361.—Conveyance of materials by the wave of translation, and traces of submarine forests in the Great Western Bay, 362.

— Groyues on the South Devon coast, viii. 201.—Works executed on that coast for the purpose of collecting the beach, 205.—Beaches at Dawlish and at Teignmouth, 205.—Direction in which groyues should be placed, 205.

Drainage of towns. "On the drainage of the district south of the Thames," xiii. 64.—Remarks, 81.—Will an increase in the size of a sewer compensate for a loss of fall? 81.—Is it practicable to drain the southern district of the metropolis with little or no pumping, by adequate scouring power afforded by the Thames at high tides? 82.—Area and level of the district south of the Thames, 99, 101.—Velocity of the current necessary to prevent deposit in sewers, 103.—Objections to the discharge of the sewage into the Thames

HARRISON.

- at low water, 104.—By the existing system, the district is chiefly flooded by the hill waters, which would be remedied by a high-level intercepting sewer, 105.—Advantage claimed for artificial system of drainage of the district, 105.—The cost of flushing the sewers would be less than that of pumping, 106.
- North Sea, its tides and sandbanks, and meeting of the tides between Yarmouth and the Rhine, xx. 337.
- Rivers and estuaries. "On the obstructions to navigation in tidal rivers," viii. 310.
- HARRISON, T. E. [Telford medal, i. (1839) 9; Member of Council, xvii. 70; xviii. 164; xix. 132; xx. 108.]
- Artillery. Sir W. Armstrong's latest improvements in breech-loading guns not patented for his own emolument, xx. 485.
- Axle-boxes, new system of, not requiring lubrication, and without liability to heating, xviii. 415.
- Coal trade of the Port of London, xvii. 409.—Shipment of coal, xviii. 515, 519.
- Coal-drops at South Shields, i. (1837) 37.
- Docks. Yellow pine used for the entrance gates of the Monkwearmouth docks, xviii. 438.
- "On the Tyne docks, at South Shields, and the mode adopted for shipping coals," xviii. 490.—Remarks, 504.—Facilities for shipping coals, the form of invert of the lock, and the size of the lock chamber, 504.—Relative cost of hand-labour and of hydraulic power for opening and shutting dock gates, 514.—Influence of the construction of the Tyne docks upon the state of the tide in the river Tyne, 517.
- Ferry bridge across the Tyne, at Shields, xx. 386.
- Lock gates, and advantage of wrought-iron gates, xviii. 515.
- Locomotive engines, fuel and fire-boxes of the, on the Stanhope and Tyne railway, i. (1837) 38.
- Permanent way, xx. 279.

HAWKINS.

- Pile-driving machine, Nasmyth's, xviii. 515.
- Railway breaks, particularly self-acting break of M. Guérin, xvii. 170.
- Railway inclines. Inconvenience of inclined planes on railways, x. 252.
- HART, C.
- Locks and keys, Chubb's, ix. 340.
- Hartlepool, new pier and harbour, vi. 145, 146.
- HARTLEY, C. A. [Election, xvi. 46.]
- HARTLEY, J. B. [Election, i. (1840) 18.]
- Embankments. "On the formation of embankments and the filling-in behind retaining walls," i. (1841) 143.
- Piles, driving, iii. 200.
- Timber. "On the effects of the worm on Kyanized timber exposed to the action of sea-water, and on the use of green-heart timber from Damerara, in the same situation," i. (1840) 84.
- HARTNUM, —.
- Mines. Reasons for the discontinuance of gas-lighting in the Belgian mines, xvii. 11.
- HARTREE, W. [Election, x. 193; memoir, xix. 174.]
- HARVEY, N. O. [Election, i. (1839) 37.]
- Harvey and West's improved pump valve, ii. (1843) 195. *et seq.*, iii. 90.
- Harwich, artesian boring at, and the strata passed through, xix. 39.
- HASTINGS, Commodore Sir T.
- Fire-arms, Colonel Colt's repeating, xi. 53.—Advantage of giving the utmost perfection to weapons used in warfare, 53.—Advantage of employing revolvers against savage tribes, 53.—Essential difference between Chinese jinghals and Colt's revolvers, 54.—Trials of Colt's revolvers by Board of Ordnance, 55.—Report of trials of Colt's and Adams' revolvers by Board of Ordnance, 58.
- HASWELL, J.
- Locomotive engines, 'Wien-Raab,' ordinary goods, xv. 44.
- HATCHER, W. H. [Election, ii. (1843) 183; resignation, xiii. 184.]
- HAWES, W. [Election, xii. 109.]
- HAWKINS, G. [Election, xviii. 72.]

HAWKINS.

HAWKINS, J. I.

- Air, friction of, in pipes, i. (1837) 43.
- Boilers, annealing the tubes for water-gauges on, i. (1840) 41.
- Cements, i. (1837) 20.
- Concrete, formation of, vii. 70.
- Horse-power on turnpike roads, ii. (1843) 114.
- Lighthouses, revolving lenses in, i. (1840) 24.
- Materials, strength of, i. (1837) 28.
- Naval construction, &c. Treenails for ship-building, i. (1841) 86.
- Patent slip, ii. (1842) 136.
- Scaffolding, iii. 209.
- Screw-propeller, iii. 84.
- Steam, influence of the change of temperature upon the force and pressure of, vi. 338.
- Timber, white cedar, from Bathurst, New Brunswick, i. (1840) 44.—Application and cost of, for post and rail fencing, 45.
- Ventilation, mode of, adopted by Mr. Vesey, in the year 1808, when attempting to drive a tunnel under the Thames, vi. 190.
- Water supply. Filtering water, ii. (1843) 138.

HAWKINS, M. R. [Election, ii. (1842) 72; resignation, xiv. 108.]

HAWKINS, W. B. [Election, xvii. 410.]

HAWKSHAW, J. [Member of Council, x. 60; xi. 84; xii. 112; xiii. 123; xiv. 97; Vice President, xv. 76; xvi. 88; xvii. 70; xviii. 164; xix. 182; xx. 108.]

Aqueduct of Roquefavour, contrasted with British railway viaducts both in construction and cost, xiv. 210.

Beams. Experiments upon brick beam erected at the Great Exhibition, Hyde Park, xi. 503.—Trellis, Warren, and plate beams, xiv. 487.—The so-called neutral axis, 488.

Breakwaters, plan and construction of, xviii. 118.—Form and materials for, xix. 662.

Bridges, lattice, xi. 13.—Bridges over Leeds and Liverpool canal, and canal wharf, at Liverpool, 13.—Cost of ditto 14.

HAWKSHAW.

Canals, overcoming summits on, by lifting the water, or by lifting the boat and cargo, xiii. 210.—Manchester and Bolton canal, and plan for conveying boats over a summit on canals, 211.

Cheil bank, origin of the, and source from whence material was derived, xii. 550.

Colliers, steam and sailing, comparative cost of transit by, xiv. 359.

Defences, national, xx. 448.—Mode of construction to be applied to forts when of iron, 449.

Docks. Economical system of construction adopted at the Victoria (London) docks, xviii. 488.—Shipment of coals at the Tyne docks, and in South Wales, 522.

Drainage of land. Danger of generalizing on engineering subjects, and effect of the under-drainage of land, xx. 215.

Drainage of towns. Deodorization, and drainage of the district, south of the Thames, xiii. 110.—Proposed large intercepting sewers for the drainage of the metropolis, xv. 230.

Electric telegraph, xx. 49.

Execution of works in foreign countries, and supervision exercised by the respective Governments, xviii. 20.—Mode adopted of carrying on the works on the Madras railway by small sub-contracts, and generally as to the best plan of executing similar works in foreign countries, xix. 621.

Foundations, difference in the methods of obtaining, in Bengal and in Madras, xvi. 457.

Fuel, combustion of, in locomotive engine-boilers, and as to Mr. McConnell's new engine, xii. 414.

Girders, necessity of testing, for railway purposes, xi. 238.—Strength of cast and wrought iron girders, xiii. 474.—Iron girders, xviii. 361.

Gold. Theory of the vertical structure of gold-bearing rocks, xv. 59.

Horse-power, unit of, x. 310.

Iron, apparent absence of expansion and contraction in lengths of, xi. 283.

Locomotive boilers, experiments to deter-

HAWKSHAW.

- mine the evaporative powers of, xii. 425.
- Locomotive engines. Causes of the fracture of the driving-axes of locomotives, xiii. 469.—Jenkins's system of coal-burning in locomotive engines, as applied on the Lancashire and Yorkshire railway, xix. 565.
- Machines. Tendency to manufacture still finer silk-twist and cotton yarn, xiii. 369.
- Masonry. Mode of putting together, x. 233.—Different kinds of, 300.
- Metals. Effects of compression and extension upon metals, xiii. 470.
- Mortar. Assumed difficulty of making it good, x. 235.—Manufacture of, 301.—Use and value of iron in hydraulic mortar, xvii. 439.—Old Roman mortars, 440.
- Naval construction, &c. Mode of construction to be applied to ships when of iron, xx. 449.
- Patents. Objections to combinations of engineers, concerned in the making and maintenance of railways, for buying up patent rights for every form of rail, chair, sleeper, and fastening, xvi. 283.
- Permanent way, particularly the rails, v. 244.
- "Description of the permanent way of the Lancashire and Yorkshire, the Manchester and Southport, and the Sheffield, Barnsley, and Wakefield railways," viii. 261.—Remarks, 262.—Comparison between the longitudinal and cross-sleeper systems, and as to the wrought-iron joint-plate chair, 262, 268, 272.
- Cost of maintenance, ix. 402.—Wrought-iron rail proposed by Mr. W. H. Barlow, 402.—Longitudinal system of permanent way, 403.—Relative cost of maintenance of way, xi. 283.—Greaves' cast-iron sleepers, 284.—Duration and cost of maintenance of permanent way, 294.—Which system of construction offers least resistance to passage of trains, 295.—Construction and duration of rail-

HAWKSHAW.

- way points, xiv. 435.—Permanent way of railways, xvi. 283, 380, 384.—Materials for the permanent way of railways in India, particularly sleepers and compressed keys, xviii. 423.—Permanent way of the Riga and Dunaburg railway, 424.—Durability of permanent way, and materials of which it should be composed, especially in tropical countries, xix. 258.—Continuous rolled-iron rail-bearers, and cast-iron sleepers, and as to the stone supports used on the Manchester and Bolton railway, xx. 275.
- Pier at Southport, Lancashire, xx. 298.
- Pipes. Contraction and expansion of mains of pipes under ground, xiv. 89.
- Public works in India, extension of, and suggestions as to the supervision by Government officers of railway works, xvii. 528.
- Railway accidents, causes of, xi. 473.
- Railway breaks, xvii. 169; xix. 523.
- Railway cuttings, iii. 152.
- Railway inclines. Mode of working the Oldham incline, on the Lancashire and Yorkshire railway, x. 249.—Incline planes not so frequently used on railways as they might have been, 253.—Cases where they may be advantageously adopted, 256.—Good gradients, 250.—Inclines on the Lancashire and Yorkshire railway, 254.—Ditto on English railways, and results and manner of working them, xv. 366, 368.—Oldham incline, and adhesive capability of locomotive engines, xviii. 67.
- Railway systems. Relative expense and convenience of the locomotive and atmospheric systems, iv. 287.
- Railway trains, resistances to, and mode of conducting experiments for ascertaining the, vii. 325.
- Railways, laying out of English, xi. 464.—Restrictions to guarantees to railways in Ireland, xviii. 43.—Plan he adopted, in 1845-46, to show that the rates on the Lancashire and Yorkshire railway were too low, 44.—General style of design of the works

HAWKSHAW.

- on Indian railways, xix. 622.—Cost of railways in India and in England, 622.
- Rivers and estuaries. Effect produced by the 'pouch' in a tidal river, xii. 18.
- Roads, maintenance of macadamized, in provincial towns, xiii. 287.
- Roofs. Durability of galvanized iron roofing, xiv. 272.
- Shingle on Chesil-bank, and formation of Dungeness Point, xi. 219.
- Smoke, prevention of. Necessity for large fire-grates, and ample supply of air and boiler room, to avoid the emission of smoke from engine furnaces, xiii. 407.
- Steam-boilers, effects produced by the use of muriate of ammonia, as a means of preventing the incrustation of, v. 209.—Explosions of locomotive and stationary engine-boilers, xv. 299.
- Steam-engines. Means of ascertaining the actual power of an engine, and the standard by which it should be measured, x. 314.
- Timber, processes for preserving, xii. 229.—Necessity for care in the selection of timber for sleepers and for marine works, and as to creosoting and Kyanizing, xviii. 432.
- Tunnels. Construction and enlargement of the Lindal tunnel, Furness railway, and tunnelling operations generally, xix. 238.
- Viaducts, failures of, have frequently arisen from carelessness in slacking the centres, and in removing too large a number, x. 234.
- "Description of the Lockwood viaduct, on the Huddersfield and Sheffield railway," x. 296.—Remarks, 301.—Span of arches of viaducts, 301.
- Paddock viaduct, near Huddersfield, xi. 13.
- "Description of a cast-iron viaduct, or colonnade, constructed at Salford," xi. 241.
- , Kent and Leven, in Morecambe Bay, for the Ulverstone and Lancaster railway, xvii. 448.
- Water supply. Capabilities of the chalk

HAWKSLEY.

- formation for supplying large towns with water, ix. 373.—Quantity of water to be obtained by pumping from the chalk, xiv. 76.—Infiltration of rainfall into subterranean reservoirs, 87.—Yield from water-bearing strata, and evaporation and rainfall, xix. 48.
- Working-classes, education of, in America and England, xi. 63.
- HAWKSLEY, T. [Election, i. (1840) 45; Member of Council, xiii. 123; xiv. 97; xv. 76; xvi. 88; xvii. 70; xviii. 164; xix. 132; xx. 108.]
- Coal mines, introduction of gas, for lighting, xvii. 13.
- Docks. Construction of a sewer at the commencement of the operations at the Birkenhead docks, xviii. 507.
- Drainage of land. Effect of under-drainage, and the depth to which it should be carried, xix. 115, 126.—Drainage outfalls, and the impolicy of government interference, 117, 126.—Effect of drainage on floods, xx. 231.
- Drainage of towns. Pipe drains and brick sewers, xi. 416.—Back drainage, 417.—As to separating sewage from storm waters, 417.—Experiments by Board of Health for determining transmission of water through sewers, 417.—Separation of surface and sullage waters, xii. 57.—Sewerage of Durham, 58.—Misstatements relative to the comparatively excessive cost of the drainage works executed by the Metropolitan Commissioners of Sewers, xiii. 95.—Inferential cost of draining a town applied to the north side of the Metropolis, 96.—Fallacies promulgated by the General Board of Health, particularly in the minutes relative to the removal of soil water, or drainage, &c., 109.—Proposals for the drainage of the district south of the Thames, 110.—Influence of errors of Trial Works' Committee upon practical operations, especially in the drainage of the metropolis, xiv. 297.—As to pamphlet entitled "Memorandum on the Data employed by Mr. Bazalgette, in determining the sizes and estimating

HAWKSLEY.

- the cost of the Works, designed for the Main Drainage of the Metropolis," 297.—Town drainage, xix. 127.—Effects of urban drainage upon rivers, particularly the pollution of the river Wandle, by the sewage of Croydon, and the sewage works at Leicester, xx. 233.—Two modes of employing sewage water with a view to its beneficial application to land, 233.—Effect of the works, carried out by the Local Board of Health, for the drainage of Croydon, 249.—No pecuniary advantage to be derived from the use of sewage as manure, which should be simply deodorised, 249.
- Ericsson's caloric engine, and the 're-generator,' xii. 349, 592.
- Fluids. Formula for the discharge of air and other fluids from tubes, iv. 281.—Application of the formula to the atmospheric railway, 281, 282.—Ditto to gas, 283.—Connection between his formula for ascertaining the friction of fluids in tubes, and the results of experiments on the resistances to railway trains, v. 427.
- Fuel. Experiments on consumption of fuel under land boilers, xi. 405.—Experiments upon the relative values of coal and coke, xix. 569, 579.
- Gas, relative advantages of clay and of iron retorts for making, xvi. 323.—Leakage through the substance of clay retorts, and greater deposition of carbon therein, 324.
- Iron, fatigue of, when subjected to strain within the limits of elasticity, xiii. 473.
- Locomotive engines, coal-burning in, particularly the plan introduced by Mr. S. Hall (of Basford) on the Midland railway, xix. 569.
- Metals. Whether metals, when loaded, acquire a permanent set, xiii. 473.
- Mines, ventilation of, vi. 191.—Formula for determining the velocity of the current in mines, 192.—Government interference in mining, 192.
- Pump valves, concussion of, xii. 456.
- Railway, atmospheric, iv. 281.

HAWKSLEY.

- Railway breaks, xix. 520, 524.
- Rivers and estuaries. Case of an estuary maintained by the flux and reflux of the tide almost without the aid of upland water, xii. 16.—Relative value of upland and tidal waters in estuaries and in rivers discharging into tidal estuaries and within tidal action, xix. 118.—Effect of the removal of Old London bridge, and quantity of water flowing down the Thames in dry weather, 118.—Formation of bars, and asserted advantage of curved channels, 119.—Difference between the Inclosure Commission and a Government commission to deal with rivers, mills, &c., 126.—Importance of land waters in preventing deposits in tidal estuaries, xx. 17.—Higher elevation of the tide at Ipswich than at Harwich, and analogous instances, 24.—Area of drainage of the river Wandle, its springs and tributaries, 213.—Amount of water which usually flowed off the ground and became contributory to rivers, 214.
- Smoke, consumption of, and experiments on the combustion of, xix. 570.
- Steam boilers, theory of evaporation in, and combustion of fuel, xi. 405.
- Steam navigation, &c., economy of, dependent on four elements, xvi. 358.—Rules which ought to regulate the form of the after-part of the vessel, 359.
- Valves. Gutta percha and vulcanized india-rubber, and their application to valves, xii. 457.
- Water, discharge of, results of a series of experiments on the, by overfalls, or weirs, x. 351.—Through pipes, xii. 57.—Experiments at Alnwick on the quantity of water discharged through a pot-pipe, contrasted with similar experiments made by M. Couplet at Versailles, xiii. 117.—Ditto by Trial Works Committee of Metropolitan Sewers Commission, in 1848, to ascertain discharge of water through pipes, xiv. 291, 315.—Mr. Lealie's experiments for determining the discharge from orifices elongated by application of short tube,

HAWKSLEY.

from large and long pipes, and from sluices, and comparison of results obtained with those deduced from formulae, 298.

Water, flow of, formulae used by Board of Health to determine the, through pipes, xiv. 290.—Mr. Leslie's experiments and calculations, 295.—Resistance and friction in passing through pipes, 304, 306.—Ditto, through tubes of various materials, and by rivers, 309.

Water, friction of, passing through pipes of different materials, xi. 419.

Water meters, and difference between high-pressure and low-pressure meters, with reasons why the latter are to be preferred, xvi. 50, 64.

Water, resistances to bodies moving in. Value of the resistance which a steam or other vessel would have to overcome, when moving through the water at any given speed, xvi. 355.—Application of the formulae to pre-determine the speed of a vessel, 357.—Friction of water in pipes and on the outside of a ship, 360.

Water supply. Amount of water which may be collected into reservoirs, vii. 283.—Rainfall in the Rivington district, the amount lost by evaporation and by absorption, and the quantity flowing off the ground, 275, 282.—The greatest fall of rain occurs at the mean height of the rain-cloud, 283.—Proportion between the rainfall and the quantity of water flowing off the ground in different parts of England, 287.—Character of the water from the well at the Camden station, viii. 184.—Collection of water from drainage areas, involves the question of the rainfall, the loss by floods and by evaporation, the storage capacity of reservoirs necessary in different districts, and the amount to be supplied, xviii. 385, 398.—Amount of rainfall, and the quantity of water flowing into rivers, xix. 127.—Effect of the under-drainage of land on the water supply, xx. 215.—Evaporation, 218.—Quantity of water

HAYWOOD.

flowing into the river Colne, and amount of rainfall which penetrated the surface in the valley of the Thames, 230.—Right of ownership in underground water, and of water flowing over the surface, 250.—Underground water rights, 253.

Water-works. Melbourne gravitation water-works, xviii. 386, 397.—Fracture of pipes through embankments, 386.—As to tapering the mains, and as to pressure regulators, 387, 397.—Concussions and fractures of pipes, and means of avoiding them, 388.—Size of the main of the Liverpool Corporation water-works, 399.—Three-way sluice-valves used at Liverpool, 401.

Waves, experiments for determining the height of, xx. 361.

Weirs, oblique, construction and position of weirs on tidal rivers, and works near Tewkesbury, on the river Severn, xix. 539.

HAWTHORN, R. [Election, i. (1839) 87.]

HAY, General.

Fire-arms. Relative merits of the Enfield and the Whitworth rifles, xix. 401.

HAY, J.

Coasts, &c., changes in. "Description of the formation of the town-lands of Musselburg, on the Firth of Forth," iii. 127.

HAYS, Captain.

Screw-propeller, application of, to sailing-vessels, xiv. 395.

HAYS, W. B. [Resignation, xiii. 134.]

Breakwater at Port Elliott, Encounter Bay, xviii. 143.—Iron ditto, at Holdfast Bay, near Adelaide, 144.

Dredging-machines. "Account of a machine for cleaning and deepening small rivers, in use on the little Stour river, Kent," i. (1837) 26.

HAYWOOD, W. [Election, vii. 366.]

Drainage of towns. Separation of storm and surface waters in drainage of towns, xi. 414.—Sizes of sewers, and back drainage, 414.—Advantage of capacious brick sewers, 420.—Size of sewers, and materials to be employed, xii. 45.—Paris sewerage, 47.—Situations

HAYWOOD.

in which pipe sewers may be used, 47.—Sewerage works at Liverpool, 49.—Ditto at Leeds, 50.—Ditto at Birmingham, 50.—Extracts from Mr. Roe's report as to cost of cleansing small drains, 50.—Ditto upon the sewerage of Southampton in 1845, 51.—Remarks, 52.—Formulæ for calculating sizes of pipe sewers, 52.—Means of flushing pipe sewers, 68.—Means of providing for the interception of the sewage now flowing into the Thames, and generally affording an improved outfall for the sewers of the low-level portion of the district south of the Thames, xiii. 88.—The tidal variations cannot be used for effectually draining that district, 89.—Separating the soil, or sewage-water, from the rain-water, 90.—Use of pipes for sewers, 90.—Drainage of the district south of the Thames, 98.—Necessity for determining the capacity of large ducts for sewerage of towns, xiv. 289.—Materials for drain-pipes, or water-conduits, 310.—Effect upon the sewerage of London of damming up the upland waters of the river Thames, above London bridge, xv. 222.—Disposal of sewage in London and St. Petersburg, 223.

Paving. Relative merits of an elastic, or a non-elastic foundation for paving, ix. 222.—Duration of the paving in the City, 222.—Specimen of Euston paving laid down in Watling-street, 222.—Loss by abrasion in different thoroughfares, and mode of gauging paving-stones, 223.—Constant breaking up of the pavement, 229.—Extract from Mr. Newlands' Report for 1853, on the sewerage, paving, &c., of the borough of Liverpool, xiii. 232.—First cost of laying granite paving in Fleet-street and upon London bridge, and its durability, 234.—Amount of traffic over London bridge, 235.—Durability of the paving in different streets in the City, 235.—Ditto in Paris, 235.

Rivers and estuaries. Difference between the rivers Thames and Neva, xv. 223.

Roads, macadamized, not adapted for large

HELDER RIVER.

towns, xiii. 231.—Destruction of the roads of the metropolis by vans on narrow wheels, 236.

Smoke-prevention apparatus at Messrs. Meux's, xiv. 17.

Water, discharge of, Mr. Beardmore's tables for, agree with Eytelwein's formulæ, xiii. 117.

Haseldine's system of oscillating transverse fire-bars, for smoke consuming, description of, with remarks, xiii. 391, 406.

HEALD, G.

Arithmetical instruments. "The land surveyor's calculator," i. (1838) 25.

HEAT. Latent heat of water, and of steam (Stephenson, R.), viii. 113.—Relative expansive effect of heat, on water and on air (Armstrong, Sir W. G.), xii. 344.

— "On the conversion of heat into mechanical effect." By C. W. Siemens, xii. 571. *Vide also* AIR ENGINES.

HEATH, —.

Iron and steel. Clay's process of iron-making, ii. (1843) 85.—Converting steel, 85, 86.—Quality of Indian iron, 85, 87.

HEATH, Commander L. G..

Steam engines. "On the nominal horse power of steam engines," x. 306.

HEATHCOAT, J. [Resignation, xv. 85.]

HEATHORN, H. [Election, i. (1840) 37.]

Heating and ventilation, ii. (1842) 142, *et seq.*

Heating apparatus, Joyce's, i. (1838) 11.

HEDGER, P. [Election, xiv. 273.]

HEDLEY, T. A. [Election, ix. 57.]

HEINKE, C. E. [Election, xvi. 226.]

HEINKE, J. W. [Election, xvi. 46; Council premium, xvi. 93.]

Diving apparatus. "On improvements in diving-dresses, and other apparatus for working under water," xv. 309.—Remarks, 326, 327, 330.

— Improvements in diving-dresses, and work performed by divers and by the diving-bell at the Dover break-water, xviii. 149.

Helder canal, contrasted with the Caledonian, vi. 110, 111.

Helder river, nearly vertical banks of sea-

HELICOGRAPH.

weed and fascines used at the works upon the, *ii* (1842) 128.—Slopes of sand thatched with straw, 129.

Helicograph (screw), or logarithmic spiral compass, Penrose's, and Penrose and Bennett's sliding helicograph, *x*, 245.

HEMANS, G. W. [Walker premium, *iv*, 4; Member of Council, *xvii*, 70; *xviii*, 164; *xix*, 132; *xx*, 108.]

Arches, experiments upon elliptical cast-iron, *xviii*, 362.

Beacons, floating, construction of, with a hollow keel, *xx*, 311.

Beams. "On the brick beam at Nine Elms," *i* (1838) 16.

Bridges. "Description of a wrought-iron lattice bridge lately erected on the line of the Dublin and Drogheda railway," *iii*, 63.

— Boyne lattice bridge, and bridge over the Shannon, on the Midland and Great Western railway of Ireland, and amount of deflection in each, *xiv*, 468, 474.—Trellis bridges, 489.

Canal, Birmingham, Netherton tunnel branch of, *xix*, 278.

Foundations. Sinking cylinders, by Potts' pneumatic process, *xvii*, 63.

Datum line used throughout Ireland, *v*, 311.

Drainage of land. Arterial drainage works in Ireland, *xix*, 103.

Electric telegraph. Terminus in Ireland of the proposed Atlantic telegraph, *xvi*, 223.

Iron, wrought, forging large masses of, *xviii*, 341.

North Sea, and Lieutenant Maury's work on "The Physical Geography of the Sea," *xx*, 361.

Permanent way. "Description of the rails, sleepers, and fastenings on the Dublin and Drogheda railway," *v*, 233.—Remarks, 242.

—, fish-joints, wrought and cast-iron ways, Mr. J. Samuel's cast-iron trough lined with timber, Mr. W. H. Barlow's saddle-back rail, and Mr. W. B. Adams' suspended girder rail, *xvi*, 271.—Permanent way on a portion of the Dublin and Galway line, 273.—Machine for

HENDERSON.

cutting the beds in which the rails, or railway-chairs, lie on the sleepers, *xvii*, 42.

Railway breaks, Guérin's self-acting, *xvii*, 169.—Mr. Fay's and Mr. Newall's continuous, *xix*, 518.—Object of experiments on ditto, 523.

Railway companies. Advantage of establishing friendly relations between railway and canal companies, *xvii*, 406.

Railway embankments, formation of, through and across arms of the sea, and beside fresh-water lakes, *xiv*, 247.—Embankment in Clontarf estuary, 247.—Ditto in the Malahide estuary, 248.—Protecting groynes in ditto, 248.—Embankment in Lough Owel, 249.

Railway system in Ireland. "On the railway system in Ireland, the Government aid afforded, and the nature and results of county guarantees," *xviii*, 24.—Remarks, 43.—Operation of the Encumbered Estates Court, 43.—Guarantee system in aid of the formation of railways, 47.

Railways. Comparative economy of construction of the lines in England and in Ireland, 47.—The 'zig-zag' system of constructing railways for traversing high mountains, 68.

Roofs. Iron roof of Galway station of the Irish Midland railway, and cost of roofs, *xiv*, 265.

Timber, merits of creosote for preserving, *ix*, 54.

Weirs, effect of, on the river Shannon, *xix*, 540.

Well, sinking of a, in a district of cavernous limestone, in the west of Ireland, *xix*, 87.

HENNING, A. F.

Levelling instruments. "On Browne's patent hydraulic level," *i* (1840) 20.

HENDERSON, Captain A. [Election, *i* (1840) 26; Telford medal, *xiv*, 104.]

Boats. "Description of a new mode of steering, as applied to boats of light draught of water, navigating shallow and rapid rivers," *i* (1841) 80.

Colliers. Mr. Hodgson's system of construction, *xiv*, 352.

HENDERSON.

Marine engines. Elements affecting marine engines are continually changing, x. 314.

Naval construction, &c. General employment of iron in ship-building, and its value in increasing the strength of vessels, xiii. 35.—Other systems of construction, 35.—Combination of iron and wood in the construction of ships, 36.

Oars, use of, upwards of 50 feet in length, by the Chinese, xii. 36.

Public works in India. Importance of extended and improved means of communication, between the different parts of India, both in the interior and on the sea-coasts, xvii. 531.—Facilities for river navigation in India, and the necessity for the employment of vessels of light draught of water, 532.—Table showing the comparative capabilities, and other particulars, of the vessels in use and proposed for the navigation of the Bengal rivers, 534.—Merits of the different systems stated financially, 536.—Difficulty of determining the weight of the vessel and her capability at a given draught of water, 536.—Ports and harbours of India, 537.

Ships. As to obtaining particulars of tonnage, dimensions, displacement, weight, burthen, and resistance of ships, xiv. 408.—Clipper ships, 409.

Steam navigation, &c. "On ocean steam navigation," vi. 484.

— "On the speed and other properties of ocean steamers, and on the measurement of ships for tonnage, xiii. 1.—Remarks, 31.—Probable effects of heavy seas on long vessels, 31, 34.—Difficulty of navigating large ships in the rivers approaching the chief commercial cities, and of entering harbours and docks for loading, 31.—Dimensions of some of the large ships built by the ancients, 33.—Tonnage and external bulk of ditto contrasted with a few modern ships, 33.—Dimensions of steam-ships of the Cunard and Collins' lines, of the 'Bengal' and 'Himalaya'

HENLEY.

belonging to the Peninsular and Oriental Company, and of the 'Great Eastern,' 37.—Effect upon 'Great Eastern' of passing through a mountain wave, 37.—Difficulties in steering such a vessel, when scudding before the wind and sea, without greater power than there is in the present rudder, 38.—Importance of the ratio of breadth to length, 39.—Average speed of steam-vessels, 54.—Effects of ocean waves on large vessels, 57.—Extract from Mr. Griffiths' work on 'Naval Architecture,' relative to the steam-ship 'Georgia,' one of the largest American ocean steamers, 59.—Performances of vessels having different ratios of breadth to length, 60.—Present method of measurement for tonnage, 61, 63.

— Speed of ocean steamers, xiv. 409.

—Particulars of the performances of different vessels, xvi. 364.—Means for testing the relative qualities of vessels at sea, 365.

Waves, Dr. Scoresby's Paper on Atlantic, xiii. 34.

HENDERSON, JAMES. [Election, xiv. 273; Telford medal, xviii. 174.]

Ores. "On the methods generally adopted in Cornwall in dressing tin and copper ores," xvii. 195.

HENDERSON, JOHN. [Election, xvi. 423.]

HENDERSON, JOHN.

Roofs. Cost of iron roofs, and value of various descriptions of covering, as distinct from different principles of construction, xiv. 268.—Weight of roofs as compared with span, 271.

HENDERSON, Lieutenant-Colonel G., R.E. [Memoir, xv. 100.]

HENDERSON, P. E. [Election, i. (1838) 46; resignation, xiii. 134.]

Gas. "Specification and working drawings of the Middlesborough-on-Tees gas-works," i. (1840) 6.

Machinery. "On the machinery used for working the diving-bell at Kingstown harbour, Dublin," ii. (1842) 148.

Henley's instruments for overcoming the effects of induction in the underground

HENNET.

wires between Liverpool and Manchester, xvi. 204.

HENNET, G. [Memoir, xvii. 100.]

HENSMAN, C. L. [Election, i. (1841) 80.]

HENSMAN, H. [Election, iii. 342; Member of Council, xiv. 97.]

Engines. Experiments with a combined vapour engine on M. Du Trembley's system, but arranged to be worked by chloroform, instead of by ether, xviii. 260.

HENWOOD, W. J. [Telford medal, i. (1839) 6; election, i. (1840) 75.]

Engines. His experiments and results as to the power of the Huel Towan engine (Woods, G.), i. (1840) 80.

Steam. "On the expansive action of steam in Cornish engines," i. (1838) 13.

HEPPEL, J. M. [Telford premium, vi. 2; vii. 3; Telford medal, xvi. 92.]

Beams. Forces in action in the case of rectangular beams, xvi. 78.

— "On a method of computing the strains and deflections of continuous beams under various conditions of load," xix. 625.

Engines. Best indication of the efficiency of an engine, x. 313.

Exhibition in 1851, construction of the building for the, x. 174.

Fluids, resistance to bodies moving in. "On the relation between the velocity and the resistance encountered by bodies moving in fluids," v. 266.

Girders and tubes. "On the relative proportions of the top, bottom, and middle webs of iron girders and tubes," xv. 155.—Remarks, 191.—Action of the middle web in iron bridges, 191.

Steam. "On the expansive action of steam," vi. 316.

Working classes. Prussian workmen and English mechanics, xi. 64.

HERBERT, C. M. [Election, iii. 101.]

HERBERT, G. [Council premium, xvi. 93.]

Batteries, floating. Applicability of new form of floating body and mooring to floating batteries, xv. 13.

Buoys, beacons, sea-lights, &c. "On the construction of stationary floating bodies," xv. 1.—Remarks, 11.—Action

HIGHTON.

of waves on proposed circular, wrought-iron light-tower, 11.—Arrangements for changing the bearing-links of the cable, and for hauling it up when required, 13.—Use of Mitchell's screw moorings for proposed sea-light tower, 13.—Mooring-chain of his buoys and beacons, 16.—Trial beacon on the South Sand-Head of the Goodwin Sands, 16.— Floating beacons, particularly as to his cone-bottomed buoy, xx. 310.

HERBON, J.

Permanent way. His objections to the usual methods of constructing permanent way (Newton, W. E.), vi. 59.—Description of his system of 'trellis railway,' 60.—Ditto of a double scarf devised by him, 61.—Extracts from a letter of, on the above system, 76.

HERSCHEL, Sir J. F. W., Bart. [Election, i. (1838) 51.]

Decimal coinage, &c. Quotation of opinion of, as to the metre, the basis of the French system of measures, weights, and coins (Yates, J.), xiii. 349.

HERTSLET, C. L.

Drainage of towns, separation of storm and surface waters in, xi. 413.

HEWETT, Captain, R.N.

North Sea. Notice respecting his observations to determine the 'node' point in the North Sea, where there is no rise and fall of the tide (Murray, J.), xx. 318.

HEWETT, D. P. [Election, i. (1841) 157; memoir, xiv. 136.]

Lighthouses. "Description of the Menai lighthouse," ii. (1842) 122.

HICK, B. [Memoir ii. (1843) 12.]

Machines. "An improved plank frame for sawing deal planks of various thickness into any number of boards," i. (1841) 97.

HICK, J. [Election, iv. 186.]

HIDE, C. [Election, xvii. 541.]

HIGGIN, G. [Election, xix. 625.]

High level bridge at Newcastle, notice of various proposals for a, iv. 228.

HIGHTON, E. [Election, vi. 213; memoir, xix. 188.]

Docks. Excavation of the Victoria dock at Hartlepool, x. 295.

HIGINBOTHAM.

Electro-magnetism, application of, as a motive power, particularly as to the mode of producing electricity, and the apparatus to which it is to be applied, xvi. 420.

Telegraph cables. Submarine electro-telegraphic cables, xvi. 222. — His claim to be considered the inventor of the submarine metallic conductor as now used, 222. — Decay of gutta-percha when buried in the earth, 223. — Formula of Professor Ohm for determining the velocity of the passage of a current of electricity, 223. — Importance of a good system of code signals, 223. — Durability of submarine cables, plan of paying out a cable from the stern of the vessel, code system for use in long lengths of telegraphs, and decay of gutta-percha, xvii. 314.

HIGINBOTHAM, T. [Election, xiii. 241.]

Girders, direction of strains in sides of, xiv. 465.

HILL, J. [Election, x. 293.]

HJORTH, S. [Election, viii. 206; resignation, xii. 121.]

Hjorth's (S.) electro-magnetic engine described, xvi. 391.

HOARE, C.

Arithmetical instruments. Improved sliding rule, xiv. 524.

HOBBS, A. C. [Election, xii. 109; Telford medal, xiv. 105.]

Canals, steam navigation on. Washing away of the banks, by the passenger steam boats, on the Erie canal, xiii. 212.

Iron and steel. Welding and manufacture of puddled steel, xviii. 341.

Locks and keys. "On the principles and construction of locks," xiii. 251. — Remarks, 263. — Action of the American permutating lock, '263. — Moveable stump in his 'protector-lock,' 264. — Mitchell and Lawton's revolving curtain for closing the key-hole, 267. — Ruxton's contrivance for retaining a false key, 267. — Cotterell's 'patent climax detector-lock,' 267. — Dr. Andrews' 'snail-wheel'-lock, 267. — Picking of his till-locks, 270. — Means of preventing

HODGKINSON.

access to the moveable stump for the future, 270. — Manufacture of locks by machinery, 271.

Steam, superheated and combined, xix. 469, 483.

Steam boilers, explosions of, xv. 301.

Telegraph cables. Proposed apparatus for compensating for the rise and fall of the stern of the vessel when paying out, xvii. 329.

HOBBS, W. F. [Election, v. 244.]

Hoby's cast-iron sleeper, xi. 255.

HOCKING, S. [Election, iii. 248.]

Bridge, suspension. Dimensions and mode of manufacture of the links for the Hungerford suspension bridge, and method of drilling the eyes of the links, viii. 278.

Steam, working of, expansively in Cornwall, vi. 340, 342.

HODGE, P. R.

Fire-arms. Colt's revolvers, xi. 61. —

Tools used in manufacture of Colt's fire-arms, 62. — Introduction of machinery into Government Small Arms Manufactory, at Enfield, 62.

Locks and keys. Picking of Ohubb's locks in America, and notice of Mac-kinnon's lock, ix. 336, 338. — Superiority of American locks, xiii. 268.

Telegraph cables, submerging, and use of buoys and india-rubber springs between the bottom of the buoy and the slack of the cable, so as to yield to the play of the waves without adding to the strain on the cable, xvii. 340.

Working classes. Greater amount of intelligence of working classes in United States than in England, xi. 61.

HODGKINSON, Professor E. [Election, x. 293.]

Beams. Formula for ascertaining the strength of cast-iron beams, and the difference between it and that which would be applicable to wrought-iron tubular girders, ix. 250.

Girders and tubes. His experiments on the strength of iron girders (Bray, W. B.), i. (1837) 29; (Webster, T.) 30. — Method for finding the strength of tubes, ix. 251. — Proportions between

HODGSON.

the areas of the top and bottom of tubular girders, 251.—Computations for the Conway and Britannia tubes, xv. 193.

Iron, experiments on the relative strength and other properties of, from the hematite ores of Samakoff, iii. 240.—Experiments for ascertaining the effect of temperature on the bearing power of cast iron, viii. 155, 158.—Ditto on the resisting powers of rectangular cells of wrought iron, ix. 252.—Ditto as to the comparative increased strength and tenacity of Stirling's toughened iron, xi. 239.

Metals. Loss of strength by riveting, xii. 611.

Permanent way, viii. 271.

HODGSON, J. [Election, xii. 206; memoir, xviii. 204.]

HODGSON, R. [Election, xx. 191.]

HOFMANN, Dr.

Liquid hydrocarbons, application of, for the purposes of artificial illumination, viii. 231.

HOGG, P. [Election, i. (1841) 83.]

Roofs. "Description of the roofs over Buckingham Palace, covered with Lord Stanhope's composition," ii. (1843) 94.—Remarks, 96.—Objections to asphalt, 96.

HOGGAR, R. S. [Election, ix. 182.]

HOLBORN HILL.

"Holborn Hill, and the plans for its improvement." By J. Turner, ii. (1842) 69.

HOLLDSWORTH, A. H. [Resignation, i. (1837) 7.]

HOLLAND,—.

Drainage of towns. Pipe sewers, xii. 76.

HOLLAND, F.

Water supply. "Account of boring for water through granite," (Pellatt, A.), i. (1839) 44.

HOLLAND, P. H.

Street-cleansing, advantages of mechanical, vi. 460.

HOLLAND, W. H. [Election, ii. (1842) 56.]

Paving. Euston pavement, ix. 224.—Evils of having a number of different paving-boards, 225.

Roads, relative economy of, ix. 225.

HOMERSHAM.

HOLLINGSWORTH, C. E. [Election, xx. 375.]
Hollow shafts preferred to solid ones, ii. (1843) 108.

HOLMES,—.

Machinery for the conversion of wood.

Best form for the teeth of saws, xvii. 46.

HOLTZAPFFEL, O. [Auditor, iii. 65; iv. 61;

Member of Council, vi. 46; memoir, vii. 14.]

HOLTZE, G. [Election, i. (1840) 26.]

HOMERSHAM, S. C. [Election, i. (1841) 101; Walker premium, iii. 7.]

Air engine, indicator diagrams from Stirling's, iv. 357.

Boilers. Difference in the action of priming in locomotive and in low-pressure boilers, viii. 184.—Evaporative powers of boilers, xi. 407.

Brickmaking, ii. (1843) 148.

Chalk cliffs, degradation of, xi. 219.

Drainage of towns. System of deodorising the sewage at Leicester, xx. 235.

Engines. The basis of comparison of engines should be the quantity of water evaporated, or steam used per horse power, per hour, under a certain pressure, x. 311.—Du Trembley's combined-vapour engine, xviii. 273.

Fluids, resistance to bodies moving in, Smith's tables of the, v. 289.

Horse power. Divisor for calculating the H.P. of the engine on the atmospheric railway, iii. 282.—Government rule for calculating H.P., 282.

Iron, cast, change of, into plumbago, iii. 88.

Locomotive engines, as to producing steadiness in, viii. 257.

Marine engines, employment of high-pressure steam, working expansively in, viii. 308.

Pump valves. "On the construction of valves used in pumps for raising water," ii. (1843) 195.

—, iii. 95, 97.

Railway inclines. Working of the inclined planes on the High Peak railway, with condensing engines, v. 157.

Railway trains, resistances to. Whether a side wind increases the resistance to railway trains, v. 422.

HOMERSHAM.

Railways. Summit level of the Peak Forest railway in Derbyshire, xiii. 210.
 Reservoir, Lough Island Reavy, vii. 274.
 Steam, percussive action of, i. (1841) 151.
 Water supply. Results obtained from funnel rain-gauges in the district of Longdendale, vii. 276.—Want of analogy in the amount of the rainfall in different districts, 280.—Rainfall among the hills at St. Helena, 282.—Rainfall decreases with the altitude, 284.—Amount of water flowing off the ground into the reservoir of the Ashton water-works, 284.—Amount of water yielded for consumption throughout one year, by a reservoir of given capacity, fed from a given area of drainage-ground, 286.—Quantity of water pumped up from the chalk under London, ix. 161.—Its source, 161.—Wells at Bushey Meadows, 161.—Note from W. Stapleton relative to effect of ditto, 164.—Supply of water to be obtained from the chalk under London, and whence derived, 172.—Saving effected at Wolverhampton by change from intermittent to constant system of water supply, xii. 503.—Domestic consumption of water at Brighton, 504.—Water-level in chalk formation, xiv. 72.—Water supply for new docks at Great Grimsby, 72.—Effect of pumping, upon wells in the neighbourhood of Plumstead water-works, 81.—Gauge used by Messrs. Dickinson, at Hemel Hempstead, for ascertaining infiltration of rainfall into chalk, 81.—Gauge used by Dr. Dalton for similar experiments, 82.—Depression of water-level in chalk under London, 83.—Analysis of water of Trafalgar-square well, 515.—Cause of presence of soda-salts in water of wells under London, 517.—Quality of water obtained from wells sunk in red sandstone at Liverpool, 517.—Saline matter in chalk-water, 522.—Trafalgar-square wells, their yield, and the level of the water in them, xix. 35, 45.—Supply of water obtained from the chalk, by the Charlton, Plumstead, and Woolwich, and the

HOOD.

Kent waterworks companies, 36.—Statements as to the general depression of the level of the water in the wells sunk into the chalk in the north of London, 45, 48.—Proportion of the rainfall which sank into the drainage grounds of the Wandle and the Thames, xx. 216.—Flow of water in the river Wandle below Waddon mill, 216.
 Water-wheels, ii. (1843) 64.
 HOMFRAY, F. S. [Election, xiv. 491.]
 HOOD, C. [Telford premium, i. (1840) 5.]
 Coal. "On the properties and chemical constitution of coal, with remarks on the methods of increasing its calorific effect, and preventing the loss which occurs during its combustion," i. (1840) 62.
 Fluids, elastic. "On the efflux of gaseous fluids under pressure," i. (1840) 87.
 Iron. "On some peculiar changes in the internal structure of iron, independent of, and subsequent to, the several processes of its manufacture," ii. (1842) 180.
 Railway axles, fracture of, ii. (1842) 181.
 Warming and ventilating. "On warming and ventilating public buildings and apartments, with an account of the methods which have been most successfully employed for ensuring a healthy state of the atmosphere," i. (1839) 72.
 HOON, Captain, R.N.
 Harbour of Newhaven, xii. 15.
 HOON, R. J. [Election, vi. 134; Council premium, x. 66; Telford Medal, xviii. 174.]
 Bridge, vertical lift. "Description of a vertical lift bridge erected over the Grand Surrey Canal, on the line of the Thames Junction branch of the London, Brighton, and South Coast railway," ix. 303.—Remarks, 309.
 Cement, Portland, expansion of, xvi. 443.
 Iron, economy in weight of, from using lattice beams, xiv. 474.
 Permanent way, cost of maintenance of, xi. 282.—Cast-iron sleepers and 'fished' suspended joints, 282.
 Railway cuttings, iii. 148.
 Railway stations. "On the arrangement

HOOF.

and construction of railway stations," xvii. 449.

HOOF, J. [Election, ii. (1842) 138; memoir, x. 97.]

Hokey's method of bending ships' timbers, xvii. 36.

HOOPER, E. [Election, iii. 342.]

HOOPER, H. [Election, xiii. 383.]

Piers. "Description of the pier at Southport, Lancashire," xx. 292.—Remarks, 299.

HOPE, D. T. [Telford premium, iii. 6.]

Paving. "On the relative merits of granite and wood pavements, and macadamized roads, derived from actual experience," ii. (1843) 203.

HOPKINS, E. [Election, i. (1841) 80; Council premium, xvi. 93.]

Execution of works, in the interior of South America, near the equator, the cost of labour, and quality of the timber, xix. 256.

Gold. "On the vertical structure of the primary rocks, and the general character of their gold-bearing varieties," xv. 48.—Remarks, 57.—Necessity of study of geology in the field by mining engineers, 57.—Geological sections made to suit favourite systems and theories, rather than to represent the actual condition of rocks, 68.—Direction and angular position of the primary cleavage planes, 68.—Gold districts of Virginia, in the United States, 69.—Extract from Messrs. Andres Del Rio and J. Millington's Report on ditto, 69.—Ditto from Professor Silliman's remarks on ditto, 69.—Ditto from Mr. J. D. Whitney's 'Metallic Wealth of the United States,' relative to ditto, 69.—Ditto from Messrs. Clewson and Rogers' remarks on ditto, 69.—Machines employed for extracting gold from pyrites, quartz, and slate, and difficulties experienced by old companies in working remuneratively, 70.—Quotations from works of Professor Sedgwick as to cleavage of primary rocks, 70.—Extract from Professor Blake's description of the gold regions of California, 71.—Ditto from Mr. J.

HORNE.

Wilson's 'Notes on the Gold Regions of California,' as to the Sonora diggings, 71.—Ditto from Mr. Hargrave's 'Account of his Adventures in California,' 71.—Ditto from Official Reports of the Gold Commissioners of New South Wales, 72.—Ditto from Mr. Walker's Paper on the Gold Fields of Victoria, 73.—Ditto from Mr. Howitt's account of Victoria, 73.

Junction of the Atlantic and Pacific oceans. The Chain of the Andes, ix. 74.—Geology and topography of the isthmus of Panamá, 74.—Survey of the river Bayano, 75.—Route between Chagres and Panamá, 76.—Tides on the two sides of the Isthmus, 77.—Materials of the Isthmus, 77.—Physical character of ditto, and the Isthmus of Tehuantepec, 80.—Absence of lime, and of good building timber in the Isthmus of Panamá, 87.—Geological sections of the three branches of the Andes, 182.—Inter-oceanic canal by the Atrato, xv. 397.

Mines, mechanical ventilation of, x. 48.—Laying out the workings in mines, 49.

HOPKINS, J. D.

Beams. Experiments upon brick beam erected at the Great Exhibition, Hyde Park, xi. 504.

HOPKINS, R. [Memoir, viii. 192.]

HOPKINS, T. [Memoir, viii. 11.]

HORN, J. [Resignation, xiii. 134.]

Warming and ventilating. "On warming and ventilating," i. (1837) 42.

Water supply. Depression of the water-level in a deep well at St. Luke's, ix. 176.

HORNE, J. [Election, i. (1840) 22; Auditor, 36; memoir, xvii. 102.]

Beams. "Results of experiments made with a view to determine the best figure and position for wooden bearers, so as to combine lightness and strength," i. (1837) 30.

—, position of the neutral axis, i. (1841) 122.—Experiments on the strongest form of, ii. (1842) 79.

Clocks, construction of, iv. 72, 73, 75.

Coke ovens, i. (1839) 41.

HOROLOGY.

Horse-power. Statement of the work done, by horses, and its cost, under various contractors, ii. (1843) 117, 118.

Lighthouses, lamp for illuminating, i. (1837) 45.

Mines. Mode adopted for ventilating a mine in Weardale, vi. 192.—Causes of explosions in mines, 196.

Permanent way. Use of American white cedar timber for railway sleepers, i. (1840) 45.

Railway, atmospheric, iii. 274.

Timber, effect of coal tar on, ii. (1842) 68.—Payne's process for preserving timber, 87.

Horology; on the laws of isochronism of the balance-spring, as connected with the higher order of adjustments of watches and chronometers (Frodsham, C.), vi. 224.

HORSE-POWER.

"Results of the application of horse-power to raising water from the working shafts at Saltwood tunnel, on the South Eastern railway, in 1842." By F. W. Simms, ii. (1843) 112.—Number of hours during which the horses were worked, 112.—Rate of hiring the horses, 112.—Duty performed, 112, 113.—Estimates of horse-power, 112, 116.—Quantity of work done, and its cost, 114.

Discussion.—Beardmore, N., 119.—Davison, R., 117.—Field, J., 114.—Gravatt, W., 115.—Hawkins, J. I., 114.—Horne, J., 117.—Palmer, H. R., 114.—Rennie, G., 115.—Walker, J., 115.—Wood, C., 116.

Method of, and divisor for, calculating horse-power on the atmospheric railway (Samuda, J.), iii. 275.—Government rule for calculating, (Homersham, S. O.), 282.—Standard fixed by Watt, (Farey, J.), 283.

"On the nominal horse-power of steam-engines." By Commander L. G. Heath, R.N., x. 306. *Vide also* **STREAM ENGINES.**

Horticulture, sulphate of ammonia beneficially employed in, iii. 302.

HOSKING.

HOSKINSON, Captain, R.N.

Steam navigation, &c. Average rate of speed of ocean steamers, xiii. 45.—Proper proportion of length to breadth for an efficient ocean steamer, 46.—As to H.M.S. 'Rattler' being considered a type of locomotive efficiency, 53.—As to two vessels falling off into the trough of the sea 51.—Series of returns of the performances of paddle-wheel ocean-steamers, showing the increase in the velocity, 54.—Speed to be given to auxiliary screw-vessels, xiv. 390.—Relative advantages of screw and sailing ships, 406.

HOSKEN, Captain.

Ships and steam-vessels, ascertaining the velocity of, by the log, iv. 175.

Steam navigation, &c. Effect of the screw-propeller on the working of a vessel, iv. 166.—Relative merits of screw-propellers and paddle-wheels, 167, 169, 175, 178.—Supposed increased liability of the 'Great Britain' steam-ship to 'broach to' when scudding, 177.

HOSKING, Professor.

Cuttings and embankments. "On the introduction of constructions to retain the sides of deep cuttings in clays, or other uncertain soils;" iii. 355.—Remarks, 371.

Drainage of towns. Pipe drains and brick sewers, xi. 416.

Fire-proof buildings. General insecurity of buildings, depending on either cast, or wrought iron, in cases of fire occurring, viii. 146.—Substances that suffer least from the action of fire, should be employed in the construction of fire-proof buildings, 147.—Mode of forming partitions and ceilings in Paris, 147.—Error of using thin metal as a covering to wood liable to be exposed to heat, 148.—Act 14 Geo. III., regulating the construction of warehouses, 150.

HOSKING, R.

Pump valves. "Description of annular valves for pumps for waterworks, &c.," ii. (1843) 195.—Remarks, 199.—Valves

HOSKING.

of the pumps at the Waldersay drainage, 199.

Hosking's valve, iii. 90.

HOULDSWORTH, H.

Furnaces. Allusion to his pyrometer for indicating the rise or fall of the temperature within the working part of a flue (Williams, C. W.), xiii. 402.

HOULDSWORTH, J. [Election, iii. 66; memoir, xix. 189.]

House of the Institution, alterations in, v. 482; vi. 7, 12.

Houses of Parliament, coffer-dam at the new buildings of (Dalrymple, G. S.), i. (1840) 18.—Revolving scaffolding at (Allen, J.), iii. 216.

HOWARD, T. [Election, x. 244.]

Bridges. "Description of a method of rolling bars for suspension bridges, and other similar purposes," viii. 273.—Remarks, 275.—Bars used in forming the suspension chains of the Pesth bridge, 275.—Method of rolling the bars of ditto, and tests to which the bridge has been subjected, 275.—Effect of the strain of the pin on the head of bars of suspension bridges, 279.

Iron, wrought. Forging of large wrought-iron shafts, xviii. 332.

Steam. Rationale of super-heating steam, xix. 474, 476.

HOWE, W. W. [Election, i. (1838) 15.]

HOWELL, J. [Auditor, i. (1837) 20; Member of Council, i. (1839) 27; (1840) 36; (1841) 52; resignation, xvii. 85.]

HOWITT, W.

Gold. Extracts from his account of Victoria, New South Wales (Hopkins, E.), xv. 73.

HOWKINS, J. [Election, i. (1841) 63; resignation, xvii. 85.]

Cranes, iii. 212.—'Derrick' crane, 213.

HOWLETT, S. B.

Shingle, accumulation of, at Key Haven, opposite Yarmouth, Isle of Wight, xi. 213.

HUBBÉ, H. [Election, x. 293.]

HUDDART, Captain.

Memoir of. "A memoir of Captain Huddart." By W. Cotton, ii. (1842) 56.

HUISH.

Discussion.—South, Sir J., 57.—Thornthwaite, T., 58.—Walker, J., 58.

Portrait of, presented (Walker, J.), i. (1841) 13.

Professional MSS. and instruments (Annual Report), ii. (1843) 9.

Rope machinery. "On Captain Huddart's improvements in rope machinery." By W. Cotton, i. (1838) 1.

—"On Huddart's rope manufacture." By G. D. Dempsey, i. (1838) 38.

HUGHES, E. [Election, vii. 184; memoir, xix. 190.]

HUGHES, J. [Election, i. (1841) 63; Telford medal, xi. 87, 118.]

Foundations. "On the pneumatic method adopted in constructing the foundations of the new bridge across the Medway, at Rochester," x. 353.—Remarks, 366.—Foundations for the bridge over the river Nene, at Peterborough, on the line of the Great Northern railway, compared with those of Rochester bridge, 366.—Reasons for abandoning Dr. Potts' system, and for not adopting coffer-dams at Rochester, 367.—Details of work at the new bridge at Rochester, 369.

HUGHES, R. [Election, vii. 250; memoir, xx. 163.]

HUGHES, T. [Election, iii. 173.]

Cuttings and embankments. Watson's drain-pipes, iii. 171.

—"Description of the method employed for draining some banks of cuttings on the London and Croydon, and London and Birmingham railways; and a part of the retaining wall of the Euston incline, London and Birmingham railway," iv. 78.

Hughes' machine for planing the spokes of wheels, &c., xvii. 31.

HUISH, Captain M. [Election, xi. 422; Telford medal, xii. 115; Member of Council, xix. 132.]

Railway accidents. "Railway accidents, their cause and means of prevention, detailing particularly the various contrivances which are in use, and have been proposed," xi. 434.—Remarks, 476.

HULFORD.

- Railway breaks, especially as to the application of continuous breaks, and Mr. McConnell's steam break, xix. 522.
- Railway companies. Necessity for railway companies becoming manufacturers, especially of rails, xi. 461, 463.
- Comparative cost and advantages of manufacturing railway stock by companies, or by individuals, 472.
- Railway system, English, xi. 462.
- Railways, passenger fares and merchandise rates on, xi. 462.
- Hulford's indicator card, for ascertaining the pressure on the piston of a steam-engine, xii. 431.
- HUMBER, W. [Election, xv. 418.]
- HUMBOLDT, Baron von.
- Junction of the Atlantic and Pacific oceans. Letter from, as to the different explorations of the valley of the Atrato, in Central America (Kelley, F. M.), xv. 414.
- HUMFREY, Lieutenant-Colonel J. H. [Election, i. (1841) 92; resignation, xi. 93.]
- Professional MSS. Account of Fort Regent, Jersey, iii. 873.
- HUMPHREYS, E. [Election, vii. 866.]
- Boilers. New form of boiler erected at the works of Messrs. Humphrys, Tennant, and Dykes, xv. 299.—External and internal firing of Cornish boilers, 299.—Eating away of the internal plate of a boiler near the rivets, 300.
- Colliers. Proper speed and ballasting of screw colliers, xiv. 369.
- Docks. Wrought-iron work at the Victoria (London) docks, xviii. 488.
- Engines. As to determining the actual power of an engine by the indicator, x. 314.—Allowance for the friction of the engine, 315.—As to estimating the performances of engines, from the quantity of water passing through them, as steam, in a given time, xviii. 271.
- Iron, wrought, strength of, xiii. 470.
- Machines. Necessity for care in the use of steam-riveting machines, xvii. 192.
- Marine engines. Results of using steam expansively in marine engines, xvi. 338.—Increase in the quantity of coal

HUNT.

- consumed per indicated HP., when working steam expansively in marine engines, illustrated in the records of the performances of H.M.S. 'Fury,' H.M.S. 'Terrible,' and other vessels, 361.—Loss, when working at a high degree of expansion, due to condensation, 363.—Area of the fire-grate, an approximate index of the coal expended, 363.—Marine engine giving out the greatest amount of power, per coal expended, when exerting its utmost effort, 363.
- Pump valves. Air-pump valves of a marine engine, made of vulcanized india-rubber, xii. 457.
- Steam, superheated, use of, and results of its application in the 'Ceylon,' the 'Alhambra,' the 'Nepaul,' &c., xix. 470, 473.
- Steam navigation, &c. Power expended in propelling different vessels at different velocities, xvi. 338.
- HUNT, H. A. [Election, x. 244; Member of Council, xiii. 123: xx. 108.]
- Fire-proof buildings. Construction of floors of poor-houses, at Kensington and at Westminster, to prevent spreading of fire, xii. 270.
- HUNT, J.
- Brickmaking, ii. (1843) 149, 152.
- Machine for making bricks (Farey, J.), ii. (1843) 147.
- HUNT, R. [Telford medal, xvii. 80.]
- Electro-magnetism. "On electro-magnetism as a motive power," xvi. 386.—Remarks, 401.—Circumstances which enable him to offer an opinion on this subject, 401.—Force of the current, with the magnet at rest and in motion, 402.—Action of magnetic forces through space, 414.—Quotation of Mr. Joule's opinion as to the economical production of mechanical effect from chemical forces, 415.—Convertibility of chemical into mechanical forces, 418.
- Metals. Oxland's process for removing wolfram from tin, xvii. 213.
- Water. Spheroidal state of water, and Boutigny's diaphragm boiler, xi. 404.—Quotation from his opinion as to

HUNTER.

- spheroidal form assumed by water (Longridge, J. A.), xv. 295.
- HUNTER, J. [Election, xiii. 383.]
- HUNTER, W. [Memoir, xii. 161.]
- Hunter's stone-boring machine, ii. (1842) 146.
- stone-planing machine, i. (1837) 38.
- HUNTINGTON, J. B. [Election, v. 338; Telford medal, xiii. 127.]
- Steam. "Observations on salt water, and its application to the generation of steam," xii. 506.—Remarks, 518.—Tables contained in Paper, 518.
- HURBY, H. C.
- Permanent way. His railway crossing, xvi. 298.
- HURWOOD, G. [Election, ii. (1842) 122.]
- Drainage of towns. "Description of a plan adopted for carrying off an accumulation of water from the warehouses, cellars, &c., near the wet dock at the port of Ipswich," ii. (1843) 183.
- Lock-gates. Modification in the construction of lock-gates of great width, xviii. 488.
- River Orwell. "On the river Orwell, and the port of Ipswich," xx. 4.—Remarks, 16.—The material excavated from the artificial channels deposited in a crooked reach in the natural channel of the river, 18.
- HUTCHINGS, T. [Election, xi. 422.]
- Hutton's (Dr.) experiments for ascertaining the force of gunpowder, xix. 369.
- Huygens' mathematical theory of the rotation of the earth, x. 320.—His observations on the pendulum, and proposal to make the seconds' pendulum the fundamental standard in metrology, xiii. 276.
- HYDE, J. B.
- Dredging machines. Adaptation of the American excavator for dredging, and account of its application on the Eastern Counties railway, iv. 399.
- Hydraulic apparatus. *Vide* HYDRAULIC MACHINERY.
- Hydraulic cements. *Vide* CEMENTS, and CONCRETE and RUBBLE BÉTON.
- Hydraulic engineering, present state of, xix. 110, 219.

HYDRAULIC MACHINERY.

HYDRAULIC ENGINES.

- "Description of a water-pressure engine at Illsang, in Bavaria." By W. L. Baker, ii. (1842) 55.
- "Description of the water-pressure engine at Freyberg, Saxony." By W. L. Baker, ii. (1843) 143.—Designed by Herr Brandell for draining a silver mine, 143.—Pumps worked by, and the power exerted, 144.
- Discussion.—Taylor, J., 144.
- Hydraulic level, Browne's, (Hemming, A. F.), i. (1840) 20.

HYDRAULIC MACHINERY.

- Armstrong's apparatus. "On the application of water-pressure, as a motive power, for working cranes and other description of machinery." By Sir W. G. Armstrong, ix. 375.—Cranes upon the quay at Newcastle-upon-Tyne, and at other places, 376.—Principles of these cranes, 376.—Their precision of movement and facility of application, 377.—Water-pressure engine in South Hetton colliery, Durham, 378.—General character of these engines, 379.—Four-cylinder winding engines for the mines at Allenheads, 380.—Particulars respecting the efficiency of these engines, 380.—Appendix, containing descriptions of the hydraulic crane used for shipping coals at Glasgow, of the hydraulic hoisting machines in use at the warehouses of the Albert docks, Liverpool, and of two water-pressure engines used at the lead mines at Allenheads, 382.
- Discussion.—Armstrong, Sir W. G., 384, 386.—Farey, J., 386.—Glynn, J., 384.—Richardson, J., 383, 385.—Simpson, J., 386.—Walker, J., 385.
- Armstrong's apparatus erected at the collier dock, belonging to the Regent's Canal Company, near Limehouse, (Beardmore, N.), xiii. 250.—Used for opening and shutting the sluices, the entrance gates, and the railway bridge, &c., at the Sunderland docks, (Murray, J.), xv. 439.—Ditto at the Victoria (London) docks, (Kingsbury, W. J.), xviii. 451.—Ditto at the Tyne docks, (Harrison, T. E.), 495.

HYDRAULIC PRESS.

Traversing frame. "Description of the hydraulic traversing frame, at the Bristol terminus of the Great Western railway." By A. J. Dodson, iii. 128.

Discussion.—Brunel, I. K., 129. —Dodson, A. J., 129.

Hydraulic press, used for opening and shutting a drawbridge (Dobson, G. C.), ii. (1843) 68.

Hydraulic presses, cylinders of, difficulty experienced in the manufacture of, when

HYDROSTATIC PERCOLATOR.

of large size, to resist a comparatively moderate pressure, xix. 284, *et seq.*
Vide also ARTILLERY.

Hydrogen, quantity produced by the combustion of coal gas, oil, &c., ii. (1843) 185.

Hydrostatic percolator, Loysel's, for extracting colouring matters from dye-woods, for obtaining infusions, or extracts of vegetable substances, and for medicinal or other purposes, xiii. 416.

I.

PANSON.

PANSON, —.

Fire-proof buildings. Barrett's system of fire-proof construction, xii. 267.

IBBETSON, D. J. H. [Election, iv. 291; resignation, xiv. 108.]

ICE BREAKING.

"A method of breaking ice, by forcing it upwards instead of downwards; practised on the Herefordshire and Gloucestershire canal, in the winters of 1834-35 and 1836." By S. Ballard, i. (1837) 18.

"Description and drawing of the ice-boat." By S. Ballard, i. (1838) 47.

ILLMAN, T. [Election, i. (1840) 68; resignation, xi. 93.]

Illumination, artificial, on the application of certain liquid hydrocarbons to; with a description of a new method of gas-lighting, (Mansfield, C. B.), viii. 207.

Imports and exports (foreign) of Port of London, steady increase in the, xv. 215.

Incline planes, railway. Lickey, ii. (1842) 54.—Length and angle of ditto, ii. (1843) 99, 100.—Box tunnel, 103.—Euston square, 103.—Glasgow, 103.—Experiments on the speed of trains descending, on the Great Western railway, vii. 309.

— on steep gradients of railways, and the locomotives and stationary engines employed (Drysdale, C. R.), xv. 349.

—, apparatus for ascending, xvii. 16.

— on the use of locomotive power, on gradients of 1 in 17, and curves of 300 feet radius, on railways in America, (Isaac, T. S.), xviii. 51.

— Bhoire and Thul Ghauts, on the Great Indian Peninsula railway, principal works upon the, and comparative table of the Bhoire Ghaut, and of the Giovi and Sömmering inclines, xix. 594, 597.

— *Vide also* RAILWAY INCLINES, and RAILWAYS.

INGRAM.

Inclined plane for canals; description of an inclined plane, for conveying boats over a summit, to and from different levels of a canal, (Leslie, J.) xiii. 205. *Vide also* CANALS.

Incrustation of steam boilers; on water for locomotive engines, and its chemical analysis (West, W.), v. 182.

India, list of public works on which interest has been guaranteed, &c., xix. 149.

Indian railways, on, with a description of the Great Indian Peninsula railway (Berkley, J. J.), xix. 586.

India-rubber, vulcanized, iv. 58; xii. 456, *et seq*; xiii. 433, *et seq*.

—, use of, as an insulating material for submarine telegraph cables, xx. 76, *et seq*.

Indicator card for ascertaining the pressure on the piston of a steam-engine, Hulford's, xii. 431.

Indicator diagrams, results of, from the cylinder and air-pump of the steam engine on the atmospheric railway, at Dalkey, iii. 282.

INDICATORS.

Action of, and the nature of the evidence which they furnish as to the working of a steam engine (Henwood, W. J.), i. (1838) 13.

"Results of a trial of the constant indicator, upon the Cornish engine at the East London waterworks." By Prof. Moseley, ii. (1842) 102.

Discussion.—Cowper, W., 107.—Farey, J., 107, 118.—Moseley, Prof., 103, 110, 114.—Parker, J., 110.—Wicksteed, T., 170.

Used to determine the friction of engines and machinery, ii. (1843) 70, *et seq*.

Vide also MANOMETER.

Ingram's auxiliary break, experiments on, by the Manchester, Sheffield, and Lincolnshire railway, xix. 496, 512.

INLAND NAVIGATION.

- Inland navigation, early state of, v. 19.—
 Brindley's improvements in, 23.
 ——— *Vide* BOATS and CANALS.
 INMAN, W. S. [Election, i. (1838) 39.]
 Arches of ancient buildings, v. 174.
 Institute (Northern) of Mining Engineers,
 xii. 311.
 Institution, C. E., objects of the, i. (1838) 3.
 —Alterations in the house of the, v.
 482; vi. 7, 12.—Desirability of making
 the Institution a depository of records
 connected with the profession, vi. 31.
 Instrument for setting out the width of
 cuttings and embankments (Carr, H.),
 i. (1839) 52.
 ——— for measuring pressures and tempera-
 tures; description of a new metallic
 manometer (Bourdon, E.), xi. 14.
 ——— for measuring vertical angles; descrip-
 tion of the prismatic clinometer (Pole,
 W.), xi. 23.
 Ipswich, drainage at, (Hurwood, G.), ii.
 (1843) 183.
 Irish Board of Inland Navigation abolished
 in 1829, x. 281.

IRON.

- Action of sea-water upon. "Analysis of
 a piece of the iron heel-post converted
 by the action of sea-water into a sub-
 stance resembling plumbago." By D.
 Mushet, i. (1840) 3.
 ——— cast-iron piles of Maplin Sand
 lighthouse (Walker, J.) ii. (1842) 153.
 —Corrosion of the iron sheathing used
 for ships (Wilkinson, J. J.), 168.
 ———, iii. 86, *et seq.*
 Changes in the structure of. "On some
 peculiar changes in the internal struc-
 ture of iron, independent of, and sub-
 sequent to, the several processes of its
 manufacture." By C. Hood, ii. (1842)
 180.—Red-short and cold-short, 180.—
 Changes in, caused by percussion, heat,
 and magnetism, 180.—Planishing fre-
 quently causes brittleness of, 180, 181.
 Discussion.—Hood, C., 181, 182.—Lowe,
 G., 182.—Miller, J., 182.—Moreland,
 R., 181.—Simpson, J., 183.—Woods,
 E., 181.—York, J. O., 181, 182.
 Compression and extension of, (Colthurst,
 J.), i. (1841) 60, 119.

IRON.

- Corrosion of. "On the corrosion of cast
 and wrought iron in water." By R.
 Mallet, i. (1840) 70.—Description of
 the table of results, 70.—Of iron piling
 in tidal rivers, 71.—On the action of
 foul sea-water, 71.—Ditto of hot sea-
 water, 71.—Effect on chilled cast-iron,
 72.—Ditto Welsh cast-iron, 72.—The
 protection afforded by paint, 72.—On
 metallic protectors of brass, 73.—Ditto
 of gun-metal, 74.—On the specific
 gravity of cast iron, 74.—The nomen-
 clature of fracture, 74.—Increase of
 density in large castings, 75.
 Deterioration of, by the action of cor-
 rosive sublimate (Timperley, J.), ii.
 (1842) 80; (Bull, W.), 86.
 Manufacture of (Mushet, D.), i. (1838)
 17.—Turf fuel used in the (Bald, W.),
 51.
 ——— "Description of the machinery
 and the several processes for convert-
 ing refined metal into malleable-
 finished iron at the Rhymney works."
 By J. Richards, i. (1839) 49.
 ——— "Description of Mr. Clay's new
 process for making wrought iron direct
 from the ore; as practised at the Shirva
 works, Kirkintilloch, Scotland." By
 W. N. Clay, ii. (1843) 82.—Saving as
 compared with the ordinary mode of
 manufacture, 82.
 Discussion.—Clay, W. N., 84, 86.—Fara-
 day, Dr., 86.—Fox, Sir C., 86.—Heath,
 —, 85, 86.—Taylor, J., 85, 86, 87.
 Manufacture of. Injury received by iron
 in working (Taylor, J.), ii. (1843) 93.
 —Mode of applying heated vapours in
 the (Glynn, J.), viii. 116.—Proportions
 of the materials employed, and of the
 machinery and arrangements for smelt-
 ing, 116.
 ——— "On the manufacture of malleable
 iron; with the results of experiments
 on the strength of railway axles." By
 G. B. Thomeycroft, ix. 294.—The two
 classes 'red-short' and 'cold-short'
 described, 295.—On the quality of the
 fuel used in the smelting furnace, 295.
 —Effect of the introduction of the hot-
 blast, 295.—Alternations of texture

IRON.

- from mode of manufacture, 296.—Changes induced by certain actions, 297.—Best form for railway axles, with the results of some experiments for determining this question, 298.
- Discussion.—Beattie, A., 301.—Freeman, J., 302.—Gibson, J., 301.—Thornycroft, G. B., 300, 302.
- Manufacture of. Resumé of processes, including the manufacture of wrought iron, of homogeneous and charcoal iron, and of steel, and the application of iron, especially in artillery and projectiles, and for iron-coated ships, xx. 118.
- Plumbago, change of cast iron into, ii. (1842) 153, *et seq.*
- Preservation of. "On the application of zinc by the process of electro-deposition, for the preservation of iron, as applied to engineering and other purposes." By F. Pellatt, ii. (1843) 167.—Zinc of commerce, not pure, 168.—Rapid destruction of zinc, owing to its impurities, 168.—Cost of purifying, 168.—Reports of Dumas, Graham, Kane, and Daniel, on zincing iron, 168.—Alloy of zinc and iron formed, 168.—Loss by volatilization, 168.—Pure metal alone deposited by the electro process, 168.—Expense of the process of electro deposition, 168.—Oxide of zinc affords protection to the metal beneath, 168.
- Discussion.—Pellatt, F., 169.—Walker, J., 169.
- Preservation of iron-work by dipping it into heated oil (Simpson, J.), xi. 240.—Durability of galvanized iron, xiv. 265, *et seq.*
- Results of the progressive improvement in the manufacture of, (Field, J.), vii. 84.
- Smelting, use of peat for, extracted from the Smeaton MSS. (Farey, J.), i. (1839) 87.—Chemical combination of, in smelting (Faraday, Dr.), ii. (1842) 61.—Use of anthracite in smelting (Taylor, J.), 62.
- Stirling's toughened, used for iron viaduct erected at Manchester (Jee, A. S.), xi. 226.—Details of its manufacture (Stir-

IRON.

- ling, J. D. M.), 238.—Experiments by Mr. Eaton Hodgkinson, on the comparative increased strength and tenacity of, 239.
- Strength of. Force necessary for punching holes in wrought iron (Colthurst J.), i. (1841) 60.
- Iron, "Experiments upon cast and malleable iron, at the Milton iron-works, Yorkshire, in February, 1843." By D. Mushet, ii. (1843) 126.—Mode of conducting the experiments, 126.—Results of experiments as compared with iron from other works, 127, 128.—Waste in re-melting, 128.
- Discussion.—Brunton, W., 130.—Carpmael, W., 131.—Cottam, G., 128.—Davison, R., 131, 133.—Farey, J., 129, 132.—Field, J., 130, 133.—Lowe, G., 128.—Mackain, D., 132.—May, C., 132.—Naamyth, J., 132.—Parkes, J., 129, 131.—Ransome, R., 132.—Rennie, G., 130.—Vignoles, C., 131.
- Strength of. "On the laws of the strength of wrought and cast iron." By W. Bell, xvi. 65.—Method of investigation pursued, 65.—Values of the modulus of elasticity of cast iron, in tons per square inch, derived from experiments on the tensile, compressive, and transverse strains, 66.—Remarks on the fundamental assumptions usually made in the theory of the strength of materials, 67.—Values of the forces of the outside particles of wrought-iron tubes at the time of rupture, in tons per square inch, 69.—Determination of the position of the neutral axis, 71.—Observations of Sir D. Brewster in passing polarised light through a piece of glass subjected to transverse strain, with remarks thereon by Sir J. Herschel and Dr. Robison, 72.—Values of the forces on the outside particles of cast-iron bars and beams at the time of rupture, in tons per square inch, 73.—General conclusions, 74.
- Discussion.—Barlow, P. W., 76.—Cowper, E. A., 79.—Doyne, W. T., 77.—Heppel, J. M., 78.—Phipps, G. H., 80.—Sheppard, R., 81.

IRON.

Strength of. "On the coefficients, T_e and T_r , of elasticity and of rupture in wrought iron; in relation to the volume of the metallic mass, its metallurgical treatment, and the axial direction of its constituent crystals." By R. Mallet, xviii. 296.—Earlier experiments on the strength and other properties of iron, 296.—Great increase of late years, in the size of forgings, and of rolled plates, rails, and bars, 297.—Wrought-iron differs in its powers of passive resistance, for the unit of section, in some proportion to the size of the manufactured mass, 297.—Points proposed to be dealt with in this inquiry, 298.—Coefficients T_e and T_r designed by Poncelet to express the 'work done' by an extending or compressing force, upon any elastic prismatic body, at the point where its elasticity becomes permanently impaired, and its form distorted, and at the further point where rupture occurs, 298.—Iron, whether cast or wrought, has the principal axes of its integrant crystals arranged in the lines of least pressure within the mass, 299.—Experiments to ascertain the decrease in strength of large forgings in proportion as their bulk is increased, 301.—Characters of the wrought iron from which specimens were prepared, and submitted to proof, 302.—Experiments to determine whether the same malleable iron affords a greater resistance to tension or compression, when prepared by means of hammering or rolling, as well as the determination of the relative longitudinal and circumferential strength, for equal sections of the iron, in massive cylindrical forgings, 302.—Tabular recapitulation of the experiments, 305.—Description of the massive forgings from which the specimens were obtained, and of some phenomena connected with their formation, 306.—Iron forged for the Mersey Company's gun, and for the chambers of the two mortars, each thirty-six inches diame-

IRON.

ter, 306.—Large internal rents, with jagged, crystalline, irregular surfaces, due to contraction in cooling, 307.—Explanation of the phenomenon, 308.—Two practical results, the difficulty of obtaining very large forgings of a cylindrical form quite sound, and the low measure of strength, per unit of section, of the material of these heavy forgings, 310.—Contractile strains within the mass in cooling exercise considerable influence upon the arrangement of the crystalline axes and planes of separation of the iron, 311.—Mode in which the several specimen bars were prepared for experiment, 312.—Measuring instruments employed, 314.—The Liverpool Corporation testing-machine used for the experiments on tension, 315.—Error in the registration of the strain imposed by the machine, and its amount determined, 315.—Experiments as to compression made with the American testing-instrument, in the Gun Factory, Woolwich, 317.—Conclusions which the investigation leads to, 317.—Relative resistance to tension in different directions, within the same large mass, of forged iron of cylindrical form, and within the elastic limits, 322.—Sudden and extreme inequalities of texture and of strength in heavy forgings, in different but even in closely-adjacent portions of the same mass, 322.—Iron of heavy forgings is a better material to resist compression than tension, 323.—Properties of puddled steel, its peculiarities of great elastic range, extensibility and ultimate strength, both tensile and compressive, 325.—Strength of slabs of bars of iron prepared by drawing out under the steam-hammer and by rolling, 326.—Relative resistances of tension and compression before final dislocation or rupture, 328.—Specific gravities of the wrought iron experimented on, both before and after compression, 329.—Mean results deducible from the experiments, 329.—Appendix Table I., general abstract of the

IRON AND STEEL.

principal results as to tension, 330.—Ditto, Table II. Ditto, as to compression, 330.—Ditto, Table III., relations of extension to compression, under equal strains, at the elastic limit for tension, 330.—Ditto, Table IV., ditto at the elastic limits respectively of tension and of pressure, 330.—Ditto, Table V., comparative practical data in reference to English iron, deduced from the results of these experiments, and from other authorities, 330.—Ditto, Table VI., specific gravities of the several specimens of wrought iron, before and after compression, 330.

Discussion.—Bramwell, F. J., 339, 341.—Clay, W., 333, 340, 343.—Gregory, C. H., 341.—Hemans, G. W., 341.—Hobbs, A. C., 341, 342.—Howard, T., 332.—Locke, J., 331, 347.—Mallet, R., 331, 343.—Maudslay, H., 339.—May, C., 340.—Newton, W. E., 341, 342.

Strength of. Blaenavon cast iron (Rennie, G.), xviii. 356.—Increase of strength obtained by admixture of wrought with cast iron as proposed by the late Mr. Morris Stirling, 357.

Vide also ARCHES, Cast iron elliptical; ARTILLERY; FIRE-PROOF BUILDINGS; IRON WORKS; METALS, Corrosion of; METALS, Fatigue and Fracture of; and RAILWAY AXLES.

IRON AND STEEL.

Manufacture of. Process of converting iron into steel, i. (1839) 30.—Clay's process, ii. (1843) 84, *et seq.*—Steel, from the hæmatite ores of Turkey, (Durham, —), iii. 247.—Cast steel made under the 'Uchatius' system, xvi. 287.

—, Bessemer process. "On the manufacture of malleable iron and steel." By H. Bessemer, xviii. 525.—The blast-furnace almost universally employed, as a preliminary process in the production of malleable iron, 525.—The puddling process, 525.—This process introduces into the metal more or less cinder, and other mechanically mixed impurities, 526.—The different degrees of refinement and decarboniza-

IRON AND STEEL.

tion of the numerous lumps of metal which compose a puddle ball, render the production of a homogeneous mass, by that means, a desideratum not yet achieved, 527.—In the working of the other malleable metals, all these difficulties are avoided, by casting the metal in a fluid state into moulds, 528.

—The Bessemer process proposes to bring malleable iron, or steel, into the same category with the other malleable metals, and by its purification in a fluid state, to avoid the diffusion of cinder throughout the mass, 529.—Objections to the process made by practical iron-masters, 530.—Chemical investigation pointed out the source of difficulty, showing that red shortness was produced by sulphur, and cold shortness by phosphorus, 531.—Manufacture of tool steel, 532.—The form of converting vessel used for the production of malleable iron and steel by the Bessemer process, 533.—Strength of plates of puddled iron of different manufacture, 538.—Cost of production of plates for boilers and for shipbuilding, increases considerably with the increase of weight, 539.—Apparatus for producing endless sheets from fluid metal, 539.—Facility which the Bessemer process affords, of forming masses both of malleable iron and of steel, of a size suitable for the heaviest ordnance, without any welding together of separate slabs, or the more costly method of building up the gun with pieces accurately turned and fitted together, 542.—Results of a number of trials made at the Royal Arsenal, Woolwich, as to the tensile strength of Bessemer iron and steel, 543.—Forging of large masses of cast steel, 544.—The Bessemer process rapidly extending itself over Europe, 544.

Discussion.—Bessemer, H., 548, 553.—Bramwell, F. J., 547.—Brown, T., 549.—Cowper, E. A., 552.—Gladstone, T. M., 550.—Locke, J., 547.—Riley, E., 552.—Wilmot, Col. E., 550.

Puddled steel (Mallet, R.) xviii. 325;

IRON BARQUE.

(Clay, W.), 337, 343.—As to welding ditto (Hobbs, A. C.), 341.—Manufacture of ditto, 341.—Its applicability for shafts, cranks, piston-rods, &c. (Mallet, R.), 346.

Iron barque 'Josephine,' of Liverpool, account of the, (Masters, Capt.), vi. 297.

— bars and chains, experiments as to the strength of, xvi. 303.

— beams. *Vide* BEAMS, and GIRDEES.

IRON, CAST.

Chemical constitution of cast iron in the various stages of production (Farey, J.), iii. 305.

Effects of fire and extreme heat upon, viii. 143, *et seq.* *Vide* also FIRE-PROOF BUILDINGS.

Galvanic action, changes produced in, by, iii. 85, *et seq.*—Ditto when exposed to the action of salt water, or in mines, and in various other positions, vii. 157, *et seq.*

Manufacture of, (Fairbairn, W.), xviii. 356.

Strength of. "On the increased strength of cast iron produced by the use of improved coke." By F. C. Calvert; with a series of experiments by W. Fairbairn, xii. 352.—Chemical action in the blast furnace not sufficiently attended to, 352.—Necessity for proper admixture of materials, 353.—Analyses of the various quantities per cent. of silicon existing in cast iron, 354.—Analysis of puddling-furnace slag, or scoria, at Ebbw Vale, 354.—Advantage that would result from employment of pyrometer when the hot blast is used, 355.—Injurious action of impure fuel on the quality of the iron, 356.—Addition of chloride of sodium recommended, either with coals when introduced into the blast furnace, or, where coke is used, during the process of coking, 356.—Coke so prepared deprived of sulphur, 357.—Action of the chloride of sodium, 357.—Analyses of Dalmellington, Monkland, and Eglington irons, which were deprived of sulphur and phosphorus by the use of chloride of sodium in the blast fur-

IRON ORES.

naces, 358.—Experiments on the strength of cast iron smelted with purified coke, 360.—Mean of the whole experiments, 362.—Details of the results of experiments to determine the relative strength of bars of cast iron smelted by Calvert's purified and by common coke, 363.—Extracts from results obtained at the works of Messrs. Galloway, 374.

Discussion.—Bird, W., 378.—Blackwell, T. E., 376.—Brunel, I. K., 379.—Calvert, F. C., 379.—Fairbairn, W., 375, 377.—Fox, Sir O., 379.—Gibbs, J., 376.—Locke, J., 378.—May, C., 378.—Percy, Dr., 375.—Rendel, J. M., 381.

Iron-coated ships of war, conditions required in, xx. 120.—Fortification of ships of war, by means of iron plates, how far it is advisable and in what manner it should be applied, 397.—'La Gloire' and the 'Warrior,' described and contrasted, 397.—Trial trip of the 'Warrior,' 399. *Vide* also DEFENCES, NATIONAL.

Iron, corrugated, used for roofs (Evill, W.), iii. 288.—Ditto, used for bridges, 290.

Iron girders. *Vide* GIRDEES.

— heel-plate of the stern-post of the 'John Bull' steam-vessel, analysis of a portion of the (Mushet, D.), i. (1839) 80.—Analysis of the action of seawater upon the heel-post, i. (1840) 3.

— hoop bond, application of, to brick-work, i. (1838) 16, 20.

— house, for a corn-mill in Turkey, ii. (1843) 126.

— key, new hollow wrought; with remarks on the different methods of fastening railway bars in their chairs (Barlow, W. H.), iv. 49.

— lock gates, constructed in 1843, for the entrance to the wet dock at Montrose (Leslie, J.), iii. 250.

IRON ORES.

India. "Some account of the recently-discovered deposits of iron ore at the foot of the Himalayas, in Kumaon, Northern India." By W. Sowerby, xvi. 82.—Analysis of these ores, 82.—

IRON ORES.

- Results of further assays, and also of experiments on the quality of the iron manufactured at Dehchowree, 83.
- Discussion.—Sowerby, W., 84.
- Middlebro'-on-Tees, sample of iron made from ore found near, (May, C.), xi. 28.
- Analysis of iron stone at Eston, in Cleveland, 29; (Rendel, J. M.), 160.
- Northampton, vein of iron ore at, (Rendel, J. M.), xi. 161.
- Samakoff, in Turkey. "Experimental researches into the properties of the iron ores of Samakoff, in Turkey, and of the hematite ores of Cumberland, with a view to determine the best means for reducing them into the cast and malleable states; and on the relative strength and other properties of cast iron from the Turkish and other hematite ores." By W. Fairbairn, iii. 225. — Method of smelting, 225. — Hematite of Porto Nuovo, 225.—Clay's process of smelting, 226, 235.—Analysis of, 226.—Hematite of Ulverstone, 227.—Hague's report of experiments on smelting, 229.—Clay's ditto, 230.—Chemical composition, 231.—Separation of the siliceous, 231.—Analogy between the smelting of iron and the making of glass, 231.—Mixture of minerals necessary for producing good iron, 234.—Magnetic ore, 234.—Difficulty of using rich ore in the blast furnaces, 234.—Form and dimensions of furnaces for smelting rich ores, 235, 238. — Production of wrought iron direct from hematite ores, 237, 239.—Waste in working hematite ores, 237. —Puddling by Clay's process, 239.—Experiments on the relative strength and other properties of iron produced from the hematite ores of Samakoff, 240.—Steel from Asiatic iron ore, 240.—Table of strength, &c., of nearly all the kinds of iron produced in England, 242.—Rule for calculating the strength of beams, 244.
- Discussion.—Braithwaite, F., 245.—Durham, —, 247.—Philips, R., 245.—Slate, A., 245.—Taylor, J., 245.—Vignoles, C., 245.

IRON WORKS.

- Iron passage-boat, description of the 'Non-such,' plying on the Limerick navigation, between that place and Killaloe, (Williams, C. W.), i. (1840) 28.
- permanent way, on the results of trials of varieties of, (Fox, F.), xx. 259.
- piles, proper quality of cast iron to be used, iii, 88.
- pipes, porosity of, iii. 303, 304.
- plates, results of trials with the Whitworth and the Armstrong artillery and projectiles against wrought, xix. 397, *et seq.*—Government experiments on, and the quality best able to resist the impact of shot, xx. 421, *et seq.*
- rails of railways, corrosion of, ii. (1843) 177.—Expansion and contraction of, xi. 275, 280, 283.
- reservoir for Glasgow water-works, (Mackinn, D.), ii. (1843) 139.
- safes, strong-rooms, and chests, vii. 185; viii. 154; ix. 329. *Vide also FIRE-PROOF BUILDINGS; and LOCKS AND KEYS.*
- sheathing for ships (Wilkinson, J. J.) ii. (1842) 168.
- ship building, ii. (1842) 168; (1843) 175, *et seq.*; v. 96; vii. 35, 39.—Value of iron in increasing the strength of vessels, xiii. 35.
- steamer, the first constructed by A. Manby in 1821, ii. (1842) 168.
- steam-tug 'Alice,' description of the engines, (Patrick, J.), i. (1840) 54.
- vessels, a tabular statement of the dimensions and proportions of forty, (Kendall, Lieut.), i. (1841) 146.
- IRON WORKS.
- Butterley. "Description of the blast furnaces, and of the barrow used for filling the charges of mine and coke into them, at the Butterley iron-works, Derbyshire." By S. C. Kreeft, ii. (1843) 119.—Egyptian arch, used in the construction of, 120.—Barrow, and mode of filling, 120.—Charges of minerals, fuel and flux, 120.—Yield and produce, 120.—Engine for blowing the blast, 121.
- Milton, Yorkshire, (Mushet, D.), ii. (1843) 126.

IRRIGATION.

Welsh. "Description of the mill, forge, and furnaces of a Welsh iron-works."

By T. G. Hardie, ii. (1842) 60.

Discussion.—Faraday, Dr., 61.—Lowe, G., 61.—Taylor, J., 62.—Wallace, J., 61.

Irrigation by liquid manures, xiii. 118.—

Ditto of land near large towns, especially the Craigentenny meadows (Edinburgh), at Croydon, at Stanley Green (Fulham), etc., and the effect of the system upon the health of the district, 233, *et seq.*

Irrigation and Canal Company, Madras, xix. 146.

Irrigation works in the Departments of Vaucluse, Gard, Var and Dauphiné, xiv. 191.

—— India, xvii. 485.

——, lock-meter used in Lombardy for measuring water for, ii. (1843) 200.

—— Lombardy, xiv. 191; xix. 82.

—— Madras Presidency, in connection with the rivers, xix. 80.

IRVINE, Lieutenant-Colonel, R.E. [Memoir, x. 87.]

ISAAC, T. S. [Council premium, xix. 155, 193.]

Railway curves and inclines. "On the use of locomotive power, on gradients of 1 in 17, and curves of 300 feet radius, on railways in America," xviii. 51.—Remarks, 64.—Mountain Top incline, on the Virginian Central railroad, the engines employed upon it, and the cost of working, 64.—The 'zig-zags' on the second incline of the Baltimore and Ohio railway, 69.

ISAACS, L. H. [Election, xviii. 72.]

Isochronism of the balance spring, on the laws of the, as connected with the higher order of adjustments of watches

ISTHMUS OF SUEZ.

and chronometers (Frodham, C.), vi. 224.

Isthmus of Panama, facilities for a ship canal communication between the Atlantic and Pacific oceans through the, (Lloyd, Lieut.-Col.), ix. 58. *Vide also* JUNCTION OF THE ATLANTIC AND PACIFIC OCEANS.

ISTHMUS OF SUEZ.

"On the Isthmus of Suez and the canals of Egypt." By J. Glynn, x. 369.—Inquiry as to the means of transit from the Mediterranean to India, 369.—Plan adopted of making part of the journey by canal, from Alexandria to Cairo, and part by land-carriage, from Cairo to Suez, 370.—Ancient canal from the Nile to the Red Sea, through the valley leading to the Bitter Lakes, and from thence to near Suez, 370.—Works restored about the year 644, 371.—Report and survey of this canal by M. Lepère, and plan and estimate for restoring the ancient navigation, 371.—Geographical features of the Isthmus of Suez, 373.—Rise and fall of the tide in the Red Sea and in the Mediterranean, 373.—Extract from report by Colonel Chesney of an examination of the country between the Mediterranean and the Red Sea, particularly as to the coast and the Lake Menzaleh, 374.—Project for making a ship canal from the Mediterranean to the Red Sea, as revived by M. de Lesseps, 374.—Extract from report of International Commission appointed to inquire into the practicability of the project, and list of members of the Commission, 375.

Discussion.—Braithwaite, F., 379.—Glynn, J., 376.—Greaves, C., 379.—Stephenson, R., 376, 380.

J.

JACKSON.

JACKSON, —.

Horse power. Working and feeding horses on contract work, ii. (1843) 118.

- JACKSON, G. B. W. [Election, i. (1841) 168; Walker premium, iii. 7; Telford medal and Council premium, vii. 2; Council premium, viii. 6; resignation, xi. 98.]

Canals. "Description of the Great North Holland Canal, with an account of the mode of gaining land from the sea by polders, and of the art of building with fascine work, and an account of the works at Nieuwediep," vi. 81.—Remarks, 110.—Contrast of the Great North Holland canal with the Caledonian canal, 110.—Shore-protection works of the Dutch, 117.—Construction of the Helder dyke, 123.

Permanent way. "An account of the permanent way of the Birmingham and Gloucester railway," ii. (1842) 53.

Rivers. "The engineering of the Rhine, including a translation of M. Van den Bergh's Paper 'On the improvements of the Moselle,'" vii. 211.

Timber. Experiments for testing the possibility of preserving timber from the ravages of the white ant, ix. 45.

JACKSON, Lieutenant, R.N.

Timber. Burnett's process for preserving timber, xii. 230.—Specimens of timber, rendered uninflamable by Burnett's process, 240, 266.

JACKSON, M. B. [Election, xviii. 406; Council premium, xix. 155, 198.]

Water supply. "On the water supply to the city of Melbourne, South Australia; comprising a brief description of the Melbourne gravitation water-works," xviii. 363.

JACKSON, R. W. [Election, x. 245.]

Blasting under water. Submarine blasting and dredging at the West Hartlepool harbour and docks, x. 295.

JEBB.

Colliers, steam and sailing, xiv. 355, 358. Harbours of refuge, situations for, on the east coast of England, xx. 354.

Tides of the North Sea, xx. 351.—Admiral Beechey's observations on the tides of the English Channel, and his division of the tides into establishments, 352.—Currents on the Dogger Bank, 362.

JACKSON, W. [Election, xii. 109.]

Jacobi's (Prof.) experiments as to the use of electro-magnetism as a motive power, xvi. 389.

Jacquard-machine, Martin's improved, description of, (Laforest, E.), xiii. 365.

JAMES, A. [Election, xvii. 410.]

JAMES, Captain H., R.E. [Election, xviii. 261.]

JAMES, J. [Election, xii. 109.]

Bells. "On the process of raising and hanging the bells in the clock tower at the New Palace, Westminster," xix. 3.—Remarks, 18.—Composition of bells, 18.

Friction rollers, xviii. 414.

Punching. Larivière's system for simultaneously punching a number of holes, xiii. 266.

Steam, superheated, xix. 482.

JAMESON, J. W. [Election, xviii. 525; Watt medal, xix. 155, 196; memoir, xx. 164.]

Combined vapour engine. "On the performances of the screw steam-ship 'Sahel,' fitted with Du Trembley's combined-vapour engine, and of the sister ship 'Oasis,' fitted with steam-engines worked expansively, and provided with partial surface condensation," xviii. 233.—Remarks, 294.

JAY, J. [Election, xii. 272.]

JEAKES, W. [Election, i. (1838) 21.]

JEBB, R.

Drainage of towns. Extracts from his report (1854) to Viscount Palmerston,

JEE.

upon the system of drainage pursued in the metropolis, particularly with reference to the use of tubular pipe sewers for large cities (Doulton, F.), xii. 62.

JEE, A. S. [Election, iii. 173; memoir, xviii. 198.]

Bridge, Royal Border, at Newcastle, x. 240.

Locomotive engine constructed for the Santander and Alar railway, in Spain, and results of two experiments on the Lickey incline, xv. 369.

Viaducts. "Description of the Dinting Vale viaduct, on the line of the Sheffield and Manchester railway," v. 216. —Remarks, 218.

— "Description of an iron viaduct, erected at Manchester, on the joint station of the London and North-Western, and the Manchester, Sheffield, and Lincolnshire railways," xi. 224.

Jeffreys' form of grate for burning coal in the locomotives on the Shrewsbury and Hereford railway, and results of the use of coal, xvi. 32.

JEFFREYS, J.

Air engines. Principles of the operation of the respirator, iv. 360.

JENKIN, F. [Election, xix. 130.]

Telegraph cables. Telegraph cable between Alderney and Portland, xx. 81. —Repairs of the Mediterranean Telegraph Company's cable between Sardinia and Africa, 81.—Marine animals found attached to the cable, 81.—Remedies for the disasters which had occurred to submarine cables, 83.—Corrosion of cables, 84.—Instruments employed in ascertaining the resistance of cables, 84.—Electrical phenomena connected with submarine cables, and practice of expressing the resistance of gutta percha by units of resistance, as introduced by Professor W. Thomson, 85.—Electrical condition of the Red Sea and the Bangoon (Malta-Alexandria) cables, 85.—Question of units, 87.

JENKIN, S. W. [Election, xix. 489.]

JENKINS, H. B.

JOHNSON.

Smoke, prevention of, xiv. 15.—Apparatus at Messrs. Meux's brewery, 15.—Fuels used at ditto, 16.

Jenkins' system of coal-burning in locomotive engines, xix. 552.

Jenkyn's valve, iii. 90.

Jennings' sluice valve, xii. 272.

JERMYN, G. A. [Election, i. (1838) 26.]

JERRARD, —.

Smoke prevention apparatus, xiii. 411.

JERVIS, Captain, R.A.

Fire-arms. Service bullet used with the Enfield rifle, xix. 376.

JERVIS, Colonel. [Election, i. (1841) 163; memoir, xi. 106.]

JERVIS, Major. [Election, v. 162; resignation, viii. 9.]

JERVOIS, Lieutenant-Colonel, R.E. [Election, xvi. 226.]

Defences, national. Experiments upon iron plates, and upon a combination of iron and stone, for embrasures, xx. 424. —Desirability of discussing the subject of the national defences, 439. —Duty of the navy, the protection of the colonies, of commerce, and of the mercantile marine, 440. —Necessity for fortifying the naval ports and dockyards, both on the seaward and the landward sides, so as to set the fleet free, 442.—Construction of permanent defensive works near London, 445. —Assistance which civil engineers could render in case of invasion, 446.—Sum voted for coast defences, 503, 522.—Sum to be expended upon works of fortification at Dover, 522.

JEVONS, T. [Election, i. (1840) 53.]

JOBSON, R. [Election, x. 192.]

JOHNS, J. W. [Election, xviii. 72.]

Pile-driving. Nasmyth pile-drivers, xviii. 511.

JOHNSON, J. H. [Election, ix. 375.]

JOHNSON, J. S.

Steam boilers, effects produced by using muriate of ammonia, as a means of preventing the incrustation of, v. 207

JOHNSON, R. [Election, xv. 281.]

JOHNSON, T. M. [Election, xi. 422.]

JOHNSON, W. [Election, i. (1840) 26; resignation, xiii. 184.]

JOHNSON.

JOHNSON, W. [Election, ix. 303.]

JOHNSON, W. S.

Gas burner, v. 483.

JOHNSTON, T. M. H. [Election, xix. 263.]

JONES, D. H. [Election, xx. 292.]

JONES, General Sir H. D. [Telford medal, ix. 95.]

Breakwaters. "Observations upon the sections of breakwaters as heretofore constructed, with suggestions as to modifications of their forms," ii. (1842) 124.

— and piers. Forms of breakwaters, xviii. 99, 131. — Admiralty pier at Dover, 100. — Objects for which breakwaters are required, to be borne in mind in determining the form, 119.

Bridgea. "Description of the bridge erected at Athlone, by the Commissioners for the improvement of the river Shannon," viii. 296.

Diving-bells. Machinery for working the diving-bell used in the extension of the pier at Kilrush, in the river Shannon, v. 247.

JONES, J. E. [Telford medal and premium, i. (1840) 5; resignation, xiii. 184.]

Drainage of towns. "The sewage of the city of Westminster described and delineated," i. (1839) 63.

JONES, J. H. [Election, ix. 375.]

Drainage of land. Depth to which the under-drainage of land should be carried, xix. 125.

JONES, M. [Election, ix. 57.]

JOPLING, C. M. [Election, iv. 186.]

JOPLING, J., Jun. [Election, xii. 109.]

JOPLING, T. T.

Water-meters. "On recent improvements in water-meters," xvi. 46. — Remarks, 51. — Means of gauging the length of each stroke in his piston-meter, 51. — Accuracy of measurement by his meters, 59.

JOFF, C. [Election, xv. 47.]

JORDAN, —.

Ships and steam-vessels, iron, ii. (1843) 179.

Turbine, description of a, ii. (1842) 99.

JORDAN, J. B.

Machinery for the conversion of wood, particularly revolving tools for shaping wood, the vertical spindles of his

JUNCTION OF ATLANTIC & PACIFIC.

carving machines, the most desirable speed for the cutting edges, and the necessity for perfect balance in all fast-running machines, xvii. 40. — Machinery for the conversion of logs of American birch into the frames of school-slates, 41. — Machines for cutting the seats, on the timber sleepers, for the iron railway-chairs, 41.

Metals. Composition of gun metal, iii. 88.

Pump valves. Description of the principal pump valves used by mining engineers, iii. 88. — Elliptical disc-valve, 95, 97.

Jordan's wood-carving machinery, xvii. 31.

JOSEPH, J. A. [Election, viii. 273; resignation, xvi. 98.]

'Josephine,' account of the iron barque (Masters, Capt.) vi. 297.

JOULE, J. P.

Engines. Experiments on the subject of surface condensation, xviii. 253.

Motive-power. Researches on the economical production of mechanical effect from chemical forces, xvi. 400, 410, 415.

JOURNET, P.

Scaffolding. "Description of the system of scaffolding employed at Paris for the repairs of public buildings, obelisks, &c., and of a machine for raising bricks and other building materials," iii. 218.

Joyce's heating apparatus, i. (1838) 11.

Juckes' endless chain fire-bars, for the prevention of smoke from engine-furnaces, xiii. 390, 406.

JUNCTION OF THE ATLANTIC AND PACIFIC OCEANS.

"A review of the plans which have been proposed for connecting the Atlantic and the Pacific oceans by a navigable canal." By J. Glynn, vi. 399. — Description of the isthmus connecting the North and South Americas, 400. — Passage from sea to sea first accomplished, 401. — M. von Humboldt's observations on the chain of mountains in the Isthmus, 402. — Description of the Isthmus of Tehuantepec, 402. — Survey by Signor G. Moro, and estimate for forming a canal, 405. — Description of Isthmus of

JUNCTION OF ATLANTIC & PACIFIC.

Nicaragua, 406.—Surveys and levels by Mr. Bailly in the years 1837-38, 406.—Mr. Lawrance's account of an excursion up the river San Juan, 408.—Expedition to take the Fort San Juan, with Lord Nelson's remarks thereon, 408.—Mr. Stephens' remarks on Mr. Bailly's survey, &c., 409.—Mr. Allen's plan and estimate for a canal from Lake Nicaragua to the Pacific, 410.—Description of the Isthmus of Panamá, 412.—Messrs. Lloyd and Falmarc's levellings across the Isthmus, to ascertain the difference of level of the two seas, 414.—Mr. Wheelwright's report on the capabilities of the river Chagres, 417.—Mr. Lloyd's proposal for a short canal and railway, 418.—M. Garella's report and estimate for a canal across the Isthmus of Panamá, 419.—Descriptions of the capabilities of Mandinga Bay, Chiriqui, and the river Atrato, and proposals for using them, 423.

Discussion.—Curtis, J. G. C., 429.—Glynn, J., 427.—Napoleon, H.R.H. Prince Louis, 427.

"On the facilities for a ship canal communication between the Atlantic and Pacific oceans, through the Isthmus of Panamá." By Lieut.-Col. J. A. Lloyd, ix, 58.—Advantages of the port of Panamá, 58.—Line of levels across the Isthmus, 59.—Objections to a railway, 61.—Advantages, construction, and route of proposed canal, 62.—On the employment of convict labour for the construction of the work, 63.—Emigration to the Isthmus, 64.—Resources and climate of the Isthmus, 65.—The Scotch Darien Company, 66.—Appendix, copy of H. E. the Libertador's Commission to Captains Falmarc and Lloyd, for the examination of the Isthmus, with a translation, 68.

Discussion.—Belcher, Admiral Sir E., 89.—Glynn, J., 73, 80.—Hopkins, E., 74, 78, 80.—Lloyd, Lieut.-Col., 70, 72, 78, 80, 84, 87.—Moorsom, Capt. W. S., 86.—O'Gorman, G., 71.—Smith, T. M., 81.—Stephenson, R., 79, 81.

JUNCTION OF ATLANTIC & PACIFIC.

"On the junction of the Atlantic and Pacific oceans, and the practicability of a ship canal, without locks, by the valley of the Atrato." By F. M. Kelley (New York, U.S., America), xv, 376.—Tehuantepec route, 377.—Honduras ditto, 378.—Nicaragua ditto, 379.—Chiriqui ditto, 380.—Panamá ditto, 380.—San Blas, or Mandinga Bay, ditto, 381.—Darien ditto, 381.—Atrato ditto, 383.—Description of the river Atrato and its tributaries, 384.—Survey of ditto by Mr. Trautwine in 1852, 386.—Ditto ditto by Mr. Porter and Mr. Lane in 1853, 385.—Ditto of river Truando by Mr. Lane in 1854, 385.—Exploration under Captain Kennish in 1855, and route proposed by him, 386.—Method of entering the Truando, as proposed by Mr. Lane, 387.—Description of the line of the proposed canal, and of the works that would be required, 387.—Remarks as to supply of workmen for carrying out the undertaking, 389.—Ditto of provisions, 389.—Sanitary condition of the country, 389.—Rate and direction of the flow of water from the junction of the Truando, and supply to be depended on, 389.—Amount of discharge of water at the point of junction with the Atrato, 391.—Advantages of the Atrato route, 392.—Saving to commerce by such a communication, 392.—Appendix: summary of the estimated cost of the canal and appurtenances, 394.—Ditto; calculations relative to the commercial value of the canal, 395.—Ditto; table by Lieut. Maury, of the saving in time and distance from New York to different places by the Isthmus of Panamá, over the Cape routes, 396.

Discussion.—Beardmore, N., 410.—Black, Dr., 400.—Fitzroy, Admiral, 402.—Gisborne, L., 397.—Gregory, C. H., 405.—Hopkins, E., 397.—Kelley, F. M., 412.—Stephenson, R., 416.—Vincent, —, 409.—Webster, T., 409.—Whishaw, F., 405.

K.

KARSTEN.

Karsten's mode of analyzing cast iron, ii. (1843) 178.

Kater's, (Capt.), prismatic azimuth compass, xi. 24.

Katwyk, dykes and canal, description of (Conrad, Chev.), ii. (1842) 172.

KEARSLEY, J. [Election, x. 326; resignation, xiv. 108.]

KEATING, Professor.

Lighthouses, revolving lenses in, i. (1840) 25.

KELK, J. [Election, xx. 258.]

KELLEY, F. M. [Telford medal, xvi. 92.]

Junction of the Atlantic and Pacific oceans. "On the junction of the Atlantic and Pacific oceans, and the practicability of a ship canal, without locks, by the valley of the Atrato," xv. 376.—Remarks, 412.—Asserted unhealthiness of the climate of Central America, 412.—Route from Chagres to Panamá, 413.—Darien route, 414.—Saving in time between distant places that would be effected by a junction of the two oceans, 414.—Letter from Baron von Humboldt, as to the different explorations of the valley of the Atrato, 414.

KENDALL, H. E. [Election, i. (1838) 5; resignation, xiv. 108.]

KENDALL, Lieutenant E. N., R.N. [Election, i. (1840) 18; memoir, v. 4.]

Naval construction, &c. "A tabular statement of the dimensions and proportions of forty iron vessels," i. (1841) 146.

Steam vessels. "Description of the steam-ship 'India,' with a table of the proportions of large steam-ships," i. (1840) 50.—Remarks, 51.—Engines of ditto, 51.

KENDALL, Lieutenant W., B.E. [Election, xi. 241; resignation, xiv. 108.]

KENNARD, H. J. [Election, xvi. 188.]

KENNARD, R. W. [Election, ix. 375; Member of Council, xvi. 88.]

KINGSBURY.

KENNARD, T. W. [Election, xvi. 188.]

KENNEDY, H. [Resignation, viii. 9.]

KENNEDY, J.

Locomotive engines. Origin of the plan of constructing locomotives with cranked axles and horizontal cylinders, xvi. 22.—Dome for a steam-chamber on the boiler, 22.—'Liverpool' locomotive engine, 25.

KENNEDY, J. P. [Election, x. 245.]

KENNEDY, T.

Water-meter on the principle of measurement by capacity, in which action is given to the inlet and outlet valves by means of a tumbling weight, xvi. 55.

Kennedy's water-meter, on the piston and cylinder principle, xiii. 430.

KESSEAW, D. [Election, xiii. 364.]

Key, description of a new hollow wrought iron; with remarks upon the different methods of fastening railway bars in their chairs (Barlow, W. H.), iv. 49.

Keyham Dockyard, description of the sliding caisson at, (Fairbairn, W.), xiii. 444.

Keys, wooden, employment of, on railways, their cost and duration, iv. 50.

KIMBER, J. [Election, xix. 130.]

KINDER, T. W. [Election, xx. 106.]

KING, A. [Election, i. (1840) 26.]

Gas. Pressure gauge for indicating small amounts of pressure, ii. (1843) 192.

KING, N. [Election, i. (1838) 46; resignation, xiii. 134.]

Stone. "On the strata of stone in the neighbourhood of Whitby," i. (1838) 20.

KING, Rev. S. [Election, i. (1839) 44.]

KINGSBURY, W. J. [Election, xvii. 195; Auditor, xix. 131; xx. 107; Telford medal and Manby premium, xix. 155, 193.]

Docks. "Description of the entrance, entrance lock, and jetty walls of the Victoria (London) docks, with a detailed account of the wrought-iron

KITSON.

gates and caisson, and remarks upon the form adopted in their construction," xviii. 445.—Remarks, 478.—Wrought-iron caisson, 478.

KITSON, J. [Election, xv. 348.]

KNIGHT, G. [Election, xvi. 226.]

Tunnels. Cost of the Lindal tunnel, on the Furness railway, xix. 238.

KNIGHT, S. J. [Election, i. (1838) 12.]

KNIGHT, W. [Election, ii. (1842) 122.]

KOEHLER, H.

Permanent way. "On a peculiar form of rail, and the construction of railways in America and Germany," i. (1837) 25.

KREEFT, S. O. [Election, i. (1840) 23; resignation, xii. 121.]

KYANIZING TIMBER.

Iron-works. "Description of the blast furnaces, and of the barrow used for filling the charges of mine and coke into them, at the Butterley iron-works, Derbyshire," ii. (1843) 119.

Volute springs, and their application as bearing, buffer, and traction springs to locomotive engines and tenders, waggons, trucks, and carriages, and as auxiliary springs for common road carts and waggons, xv. 37.

KRUPP, F. [Election, xviii. 296.]

Krupp's forged steel-gun, experiments with, xix. 292, 343.

Kyanizing timber, *Vide* TIMBER, Kyanizing.

L.

LABATT.

- LABATT, H. R. [Election, i. (1841) 168.]
 Labour, convict, at Portland, profit, or loss, by the employment of, xviii. 111, 128.
 —, free and slave, relative value of, xix. 249, 262.
 —, skilled in Portugal, xviii. 18.
 Labouring force (*travail mécanique*) of a man and also of a horse, useful effect produced by, xi. 77.

LAFORNET, E.

Machines. "Description of Martin's improved Jacquard-machine," xiii. 365.

LAMBERT, T. [Election, xvi. 188.]

Valves. Flexible diaphragm water-valves, vii. 416.

LAMBERT, W. B. [Election, viii. 164.]

LAMING, J.

Steam navigation, &c. Vessels fitted with auxiliary steam power and screw propellers, vi. 294.

LAMONT, Dr.

Decimal coinage, &c. Quotation from his observations on the introduction of a new system of weights and measures into Bavaria (Yates, J.), xiii. 290.

Lamp, for lighthouses, i. (1837) 45.

—, safety, vi. 166, *et seq.*

LAMP-BURNERS.

"Description of a mode of obtaining the perfect ventilation of lamp-burners."

By J. Faraday, ii. (1843) 184.—Indispensable for healthy respiration, 185.—

By a descending current, 186.

Discussion.—Bethell, J., 189, 190.—Faraday, J., 188, 189, 190.—Harris, S., 190.

—, Faraday, J., 188, 189, 190.—Harris, S., 190.

vide also LIGHTHOUSES.

Lamps, of lighthouses, Professor Faraday's mode of ventilating, ii. (1843) 206.

—, Defries' railway-carriage roof, xviii. 162.

—, *vide* also LIGHT, ARTIFICIAL; LIGHTHOUSE LAMPS; and LIQUID HYDROCARBONS.

LANCASTER, C. W. [Election, xi. 422.]

LANE.

Artillery. Construction of cannon of large calibre, with extract from Paper on this subject by Professor Treadwell, U.S., xix. 376.—Lancaster oval guns, 377.

Land drainage, and water supply, remarks as to, in the course of the discussion on the river Wandle, xx. 210, *et seq.*

—, *vide* DRAINAGE.

Land Enclosure Company, Netherlands, works for the, xvii. 78.

Land reclaimed from the sea at Loughs Swilly and Foyle (Bazalgette, J. W.), i. (1840) 41.

LANDALE, C. [Decease, i. (1837) 7.]

LANDMANN, Colonel G. [Resignation, xiii. 133.]

Landing pier, Blackfriars, an account of the (Lawrence, F.), ix. 144.

Landing stages at Liverpool, v. 31; xvii. 78.

LAND-SLIPS.

Ashley cutting. "Account of the land-slip in Ashley cutting, on the line of the Great Western railway." By J. G. Thomson, iii. 129.—Geology of the district, 129.—Drainage, 132.—Shafts and headings, 133.—Causes of the land-slip, 133.

Discussion.—Lowe, G., 133.—Slate, A., 134.—Sopwith, T., 134.

Railway cuttings, danger of land-slips in open cuttings through chalk (Buckland, Dr.) ii. (1842) 140.

Undercliff, Isle of Wight. "Earthfalls at the Undercliff in the Isle of Wight."

By W. Rickman, i. (1840) 35.—Description of the Undercliff, 35.—Of its stratification, 35.

Discussion.—Lowe, G., 36.—Walker, J., 36.

vide also CUTTINGS; and RAILWAY CUTTINGS AND EMBANKMENTS.

Land-springs, temperature of, ii. (1843) 141.

LANE, C. B. [Election, viii. 164; Council premium, xii. 116.]

LANE.

Railways. "An account of the works on the Birmingham extension of the Birmingham and Oxford Junction railway," xi. 69.

LANE, F.

Machines. Martin's improved Jacquard-machine, xiii. 368.—Process of cutting the cards by the old and the new machines, 369.—Improved system of punching machinery for producing designs for weaving, 369.

LANE, M. [Election, xx. 258.]

LANE, W. [Election, i. (1840) 33; resignation, xiii. 134.]

LANG, O. [Election, i. (1840) 18.]

LANGDON, W. [Election, iii. 101; resignation, xvii. 85.]

LANYON, C. [Election, i. (1840) 37.]

LAPHAM, —.

Steam boilers, method of regulating the height of water in, xvi. 308.

Larivière's system for simultaneously punching a number of holes, xiii. 266.

LARMER, G. [Election, i. (1840) 75.]

LATHAM, J. H. [Election, xix. 130.]

Lathe for cutting screws, by Shanks and Co., ii. (1843) 144.

Lattice beams, an investigation of the strains upon the diagonals of, with the resulting formulæ (Doynes, W. T., and Blood, W. B.), xi. 1.

— *Vide also* BEAMS, Lattice.

LAURENCE, S. [Election, xix. 625.]

LAURIE, J.

Decimal coinage, &c. Objections to a pound sterling as a unit for a system of decimal coinage, xiii. 310.—Suggesting either 100 farthings or 10 pence as the unit, 311.—The latter would be in harmony with the moneys of France, Holland, and America, 311.—The true division of the integer is into 100 parts, 311.—Coins for new currency, and value of existing coins in decimal numeration, 312.

Lavanchy's expanding portable bridge, xv. 27.

LAVERS, W.

Drainage of towns. Pipe drains and brick sewers, and area of pipes both for sewers and drains, xi. 419.

LEATHER.

LAWFORD, G. [Election, iv. 323; resignation, viii. 9.]

LAWFORD, W. [Election, iv. 323; resignation, viii. 9.]

LAWRENCE, F. [Council premium, x. 66; election, xvi. 188.]

Friction rollers, arrangement of, for a bearing inside a steam cylinder, where it was impossible to employ oil, xviii. 415.

Piers. "An account of the Blackfriars landing pier," ix. 144.

Sluices at the Old Ford locks, xvii. 401.—Adaptation of the principle to raise the sluices in the gates at the old entrance of the Commercial docks, 404.

LAWRENCE, Honourable A. (U.S. Minister). Fire-arms, Colonel Colt's repeating, xi. 52.

LAWRENCE, J.

Artillery, rifled, xx. 438.

Ships, armour-plated, xx. 438.

LAWES, Captain J. M., R.N. [Election, vii. 417; resignation, xiv. 108.]

Railway inclines. "Description of the mode of working an incline of 1 in 27½, on the Oldham branch of the Lancashire and Yorkshire railway," x. 246.—Remarks, 248.—Burnley branch of the Lancashire and Yorkshire railway, 249.—Cases where inclined planes might be adopted advantageously, 254.

LAWSON, J. [Election, xviii. 296.]

LEACH, S. W. [Election, vii. 184.]

River Thames. Desirability of maintaining the oscillation of the tide in the river Thames up to the highest point possible, and of preserving its tidal character, xv. 228.—Comparison between the tidal capacity of the Thames above London bridge, and below Gravesend, 229.—Improvements of the river Thames during the last thirty years, xix. 111, 112.

Lead sheathing for ships, (Wilkinson, J. J.), i. (1841) 132.

Leakage of gas through walls or retorts and through mains, xvi. 317, *et seq.*

LEAKE, Colonel.

Arches, ancient, iii. 113.

LEATHER, G.

LEATHER.

- Coal-drops, perpendicular, at Port Clarence, on the river Tees, and elsewhere (Turnbull, G.), v. 252.
- LEATHER, J. W. [Election, viii. 164.]
- LEBLANC, M.
Air. Analysis of the confined air of inhabited rooms (Faraday, J.), ii. (1843) 185.
- LEDOTEN, M.
Deodorizing and disinfecting agent, preparation of nitrate of lead proposed by him, as a (Ure, Dr.), vii. 98.
- LEE, J. C. F. [Election, xx. 292.]
- Lees' system of coal-burning in locomotive engines, East Lancashire railway, xix. 553.
- LE FANTU, W. R. [Election, xii. 601.]
- LEFEVRE, Right Honourable C. S. [Election, ii. (1842) 184.]
- LEFROY, H. M. [Election xii. 432.]
Motive power. Investigation of the quantity, volume, and elastic force of the gases into which 1 lb. of Jones' anthracite coal was decomposed by combustion, xii. 339.—Application of the elastic force of the gaseous products of combustion, 342.—Form of apparatus for ditto, 343.
- LEGG, G. [Election, xiii. 64.]
Roads. Comparative durability of the macadamized roadway at Albert place, and the paving on Albert bridge, Manchester, xiii. 236.
- LEGG, M. E.
Paving. Specimen of Euston pavement laid down in Watling-street, ix. 230.
- LEGRAND, M.
France, geological map of, ii. (1843) 165.
- Leicester sewage manure works, remarks as to the, in the course of the discussion on the river Wandle, xx. 233, *et seq.*
- Lenses in lighthouses, on revolving, i. (1840) 24.
- LEPÈRE, M.
Isthmus of Suez, report and survey of, with estimate and plan for restoring the ancient canal of Cairo, (Glynn J.), x. 371.
- LESBROS and PONCELET.
Water, discharge of, experiments on the,

LESLIE.

- by rectangular orifices (Blackwell, T. E.), x. 332.
- LESLIE, JAS. [Telford medal and premium, i. (1841) 8; Walker premium, iv. 4; Council premium, xi. 87, 118; xv. 81, 104.]
Air engine, Stirling's, iv. 358.
— "On the principle of the caloric, or heated air engine," xii. 563.
Bridge, Montrose suspension, iv. 295.
- Canals. "Description of an inclined plane, for conveying boats over a summit, to and from different levels of a canal," xiii. 205.—Remarks, 212.—Early use of canal incline-planes, 212.—Three incline-planes on the Chard canal, constructed by Sir W. Cubitt, 213.—Report by the late Mr. A. Thomson, recommending an incline-plane for adoption on the Monkland canal, 213.—New locks at Blackhill on ditto, 214.—Shortness of the supply of water, necessitating other means being taken, 214.—Blackhill incline-plane, and the mode of working it, 215.—Extract from Report of Company as to its success, 217.—Comparative expense of pumping water for canals, and of the incline-plane at Blackhill, 217.—Expenditure of water by the system of lockages, 217.—Ditto illustrated in the case of the chain of eight locks, at Corpach, on the Caledonian canal, 220.—Ditto of the Blackhill locks, 220.
- Cranes. "Description of a thirty-ton crane erected on the quay of Earl Grey's dock, Dundee harbour," i. (1841) 55.
- Docks. "Description of a pair of iron gates, constructed in 1843, for the entrance to the wet dock at Montrose," iii. 250.
- Embankments, reservoir, extract from his specification for constructing (Conybeare, H.), xviii. 389.
- Harbour, Dundee, i. (1840) 10.
- Sea defences. Groynes at Sunderland, and mode of construction adopted, viii. 195.
- Tidal observations, v. 313.

LESLIE.

Water, flow of. "On a mode of computation, whereby flood-water may be excluded from a set of gaugings taken at regular intervals, and, therefore, including floods," x. 327.

— "Observations on the flow of water through pipes, conduits, and orifices," xiv. 273.

LESLIE, JOHN.

Abattoirs. Passage of cattle through the streets of London, viii. 77.

Drainage of towns. Back drainage, xi. 419.

LESSERS, M. de.

Isthmus of Suez. His project for making a ship canal from the Mediterranean to the Red Sea (Glynn, J.), x. 374.

Letter-bags, Wordsdale's apparatus for exchanging, on railways, when the train is in motion, i. (1838) 82.

Levelling, v. 118.

LEVELLING INSTRUMENTS.

Azimuth cap as an addition to a common level (Cowper, Prof.), i. (1840) 81.

Browne's hydraulic. "On Browne's patent hydraulic level." By A. F. Hemming, i. (1840) 20.

Denton's 'A' level (Denton, J. B.), iv. 403.

Improvements in. Alterations in levelling staff (Bruff, P.), i. (1838) 47.

— "Description of an improved level and stand." By G. Townsend, i. (1841) 117.

— "Description of an improved levelling staff, and a modification of the common level." By T. Stevenson, i. (1841) 130.

LEVELLING MACHINE.

"Description of a proposed levelling machine." By J. Harrison, i. (1837) 35.

LEWIN, W. [Election, iv. 323.]

LEWIS.

"A drawing and description of a new lewis." By H. Robertson (Glasgow), i. (1837) 26.

LIDDELL, A. [Election, ii. (1843) 183; memoir, xv. 102.]

LIGHTHOUSE LAMPS.

LIEBIG, J.

Agricultural chemistry (Croft, A. A.), iii. 296.

Life-boat, cylindrical ship, Forbes', xii. 24.

Life-boats and fishing-boats, xiii. 26.

Lifting ships, new mode of, introduced by Mr. E. Clark, xviii. 171.

Lifts on the Great Western canal (Green, J.), i. (1838) 26.

Light, experiments as to, i. (1840) 25; vi. 387.

—, electricity, galvanism, and magnetism, probable identity of, and gradual development of their powers, vi. 26.

LIGHT, ARTIFICIAL.

Intensity of, i. (1840) 20, 24, *et seq.*

Lamps and candles. "Experimental researches upon the cost of the light afforded by different lamps and candles." By A. Ure, i. (1839) 75.—Mr. Palmer's new hot oil lamp, 75.—Fresnel's lamps, 75.—Bude light, 76.

Vide also LIGHTHOUSE LAMPS, LIGHTHOUSES, and LIQUID HYDROCARBONS.

— degree of light and consumption of wax, tallow, and oil, viii. 141.

LIGHTHOUSE LAMPS.

Management of, (Faraday, Prof.), ii. (1843) 190.

— "On the ventilation of lighthouse lamps; the points necessary to be observed, and the manner in which these have been, or may be, attained." By Prof. Faraday, ii. (1843) 206.—Construction of the lamps, 206.—Protection of the lamps from partial draughts, 206.—Condensation of the products of combustion upon the windows of the lanterns of lighthouses, 206.—Quantity of water produced by the oil burnt, 206.—Carbonic acid and other products of combustion removed by Faraday's system of ventilation, 206.—Conditions for the ventilation of lighthouses, 206.—Mode of ventilating fixed lights, 207.—Ditto of revolving lights, 208.—Advantages of the jointed chimneys with conical apertures, 207.—Charring of the wicks, 208.—Experiments for the Trinity House, 209.—

LIGHTHOUSES.

Adoption of the system at Tynemouth lighthouse, 209.

Vide also LIGHTHOUSES.

LIGHTHOUSES.

Ball Rock, description of the moveable beam crane used in the erection of the, in the year 1808 (Stevenson, R.), iv. 339.

—Ditto, the balance crane, ditto, 340.

—cost, of, compared with estimated cost of a circular, wrought-iron, sea-light tower (Herbert, G.), xv. 9.

Bishop Rock (Cubitt, Sir W.), ix. 188.—Objection to an open framework structure on the (Gordon, A.), 187.—Failure of (Walker, J.), 192, 194.

—, (Simpson, J.), xiii. 195.

Edystone, effect of the storm in the year 1840, on the, i. (1841) 115.—Rudyard's wooden lighthouse on, built in 1708 (Gordon, A.), ix. 189.—Cost of, compared with estimated cost of a circular, wrought-iron, sea-light tower (Herbert, G.), xv. 9.

Foundations of, (Rennie, Sir J.), vi. 148.

Gibb's Hill, Bermudas. "An account of the cast-iron lighthouse tower on Gibb's Hill, in the Bermudas." By P. Paterson, ix. 182.—Originally intended to have been of stone, subsequently found to be too friable, 182.—Form and construction, 183.—Delays in consequence of the works being under the control of the Board of Ordnance, 185.—Cost, and annual expense of maintenance, 185.—Benefits conferred by it on resident population, 186.

Discussion.—Borthwick, M. A., 189.—Gordon, A., 186, 189.—Pasley, Lieut.-Gen. Sir C. W., 194.—Rennie, Sir J., 189.—Russell, J. S., 193.—Walker, J., 189, 194.

Gunfleet sand (Simpson, J.), xiii. 195.

Holophotal system of illuminating lighthouses (Stevenson, T.), xv. 25.

Illumination of. "On the methods of illuminating lighthouses, and on a reciprocating light." By Capt. Smith, i. (1837) 44.

Discussion.—Horne, J., 45.

Illumination of. The advantages of a fixed light obtained by means of re-

LIGHTHOUSES.

fracting lenses in revolution, i. (1840) 20, 24, *et seq.*; i. (1841) 12.

Maplin Sand. "An account of the Maplin Sand lighthouse, at the mouth of the river Thames." By J. B. Redman, ii. (1842) 150; vii. 146.—Principal entrances into the Thames, 146.—The Swin, or King's Channel, on the north, 146.—Mode of construction of ordinary light-vessels, 147.—The Swin Middle light-vessel, 147.—The Sheers light, 148.—Determination to erect a fixed light on the Maplin Sand, 148.—Boring to ascertain its nature and density, 148.—Decision to employ screw-piles for the foundations, 149.—Manner in which they were screwed into the sand, 149.—Raft, or grating, of timber, as a foundation for the building, owing to the shifting of the sand, 150.—Superstructure, 151.—Lighting apparatus and lantern, 151.—Appendix, description of the construction, 153.—Ditto, principal dimensions, scantlings, &c., 155.

Discussion.—Branda, Prof., 157.—Davison, R., 158.—Donkin, B., 156.—Farey, J., 156, 157.—Glynn, J., 158.—Taylor, J., 158.—Taylor, P., 158.—Vignoles, C., 156.—Walker, J., 155, 156, 158.—Wilkins, W. O., 155.

Maplin Sand (Walker, J.), ix. 193.

Menai. "Description of the Menai lighthouse." By D. P. Hewett, ii. (1842) 122.—Position, 122.—Base not curved, but built with rectangular offsets, 122.—Light used at, 123.—Connection with the shore, 123.—Expense of constructing, 123.

Plymouth, foundation for, (Walker, J.), ii. (1842) 128.

Point of Ayr (Walker, J.), ii. (1842) 154; vii. 158; ix. 193.

Port Fleetwood, bracing of, ii. (1842) 152; vii. 156.

Silvered porcelain reflectors for, xv. 24, *et seq.*

Skerryvore (Cubitt, Sir W.), ix. 139.—Cost of, compared with estimated cost of a circular, wrought-iron, sea-light tower (Herbert, G.), xv. 9.

Smalls (Walker, J.), ix. 189.

LIGHTS.

- Sunderland. "Account of the removal of the lighthouse at Sunderland." By J. Murray, iii. 342.—The lighthouse built by Pickernell, 343.—Causes of the removal, 343.—Methods employed in scaffolding, shoring, &c., 345.—Power employed, 349, 351.—Time occupied in the removal, 352.—Cost of the operation, 354.
- Ventilation of the lanterns of (Faraday, Prof.), ii. (1843) 188.
- Vide also* BUOYS, BEACONS, SEA-LIGHTS, ETC.; FOUNDATIONS, SUBMARINE; and LIGHTHOUSE LAMPS.
- Lights, floating and fixed, comparative merits and expense of, vii. 139, *et seq.*
- , sea, buoys, beacons, etc., on the construction of (Herbert, G.), xv. 1.
- LILLEY, —.
- Water-meter, Mr. W. Parkinson's, xiii. 435.
- LILLIE, Sir J. S. [Election, i. (1839) 51.]
- Lime, used to prevent the internal corrosion of iron ships, ii. (1843) 176.
- , Greaves' blue lia, ix. 233.
- Limestone, on the, the lime cement, and the method of blasting in the neighbourhood of Plymouth (Stuart, W.), i. (1838) 35.
- Limnorea-terebra, localities where found, ii. (1842) 67.—Bavages of, prevented by the use of coal-tar pitch, 67.—Bavages of, at Teignmouth bridge, 91.—Destruction of Kyanized oak boxes by, ii. (1843) 174. *Vide also* PIERS, Old Southend; and TIMBER, Preservation of.
- LINANT BEY.
- Isthmus of Suez. His project for a canal from the Red Sea, through the Bitter Lakes, to Lake Timsah, and thence through the lagoons of Lake Menzaleh to Tineh (Pelusium), on the Mediterranean (Stephenson, R.), x. 377.
- LINDLEY, R. [Election, iv. 211.]
- LINDLEY, W. [Election, ii. (1842) 56.]
- Drainage of towns. Main features of the sewerage of Hamburg, as carried out by him (Fowler, C.), xiii. 71, *et seq.*

LIQUID HYDROCARBONS.

- LINDSAY, H. S. [Election, ii. (1843) 155; resignation, xiii. 134.]
- LINN, A. G. [Election, xvi. 46.]
- LIPKENS, A. [Memoir, vii. 10.]
- LIQUID HYDROCARBONS.
- "On the application of certain liquid hydrocarbons to artificial illumination; with a description of a new method of gas-lighting." By C. B. Mansfield, viii. 207.—Liquid hydrocarbons hitherto comparatively little used for the production of artificial light, 207.—When applied, their liquidity, and not their evaporability, has been taken into account, 207.—The excess of carbon in the composition of the common volatile oils, the obstacle to be surmounted, 208.—Two methods of rendering this carbon efficient as 'light fuel,' one by causing the vapour, as it escapes from a jet, to mix rapidly with the air; and the other, to mix the vapour, before combustion, with other gaseous matters containing less carbon, 209.—Two ways of carrying out the latter principle; one by mixing the hydrocarbons with some other inflammable spirit containing very little carbon; the other the dilution of the hydrocarbon vapours with permanent gases of inferior, or even of no illuminating power, 210.—Historical sketch of the order in time through which the naphthalization of gas has progressed, 211.—Donovan's method of conferring illuminating power on gases that were inflammable, but not luminiferous, by charging them with the vapour of hydrocarbons, 212.—Lowe's plan of increasing the lighting property of coal-gas, by passing it over surfaces of naphtha, 213.—Beale's invention for using hydrocarbons for illumination, by passing a current of air through vessels containing those liquids, 213.—Obstacles to these plans, the heat required to evaporate the only liquid hydrocarbons then accessible, 214.—Discovery of a spirituous hydrocarbon, procured from coal-tar, called 'benzole,' 215.—Method of charging common air, or non-lumi-

LIQUIDS.

niferous gas, with this highly volatile naphtha, so as to consume it for the purposes of light, 217.—Apparatus and conditions necessary for the success of the method, 220.—Burners contrived for the ignition of naphthalized air, 223.—Variations in the position and adjustment of the reservoir of liquid, 224.—Arrangement for supplying benzole gas, or naphthalized air, in towns, 225.—Data on which a calculation of the price of the light was founded, 226.—Donovan's simultaneous invention of contrivances for burning naphthalized air, 228.

Discussion.—Harding, W., 231.—Hofmann, Dr., 231.—Lowe, G., 228, 229, 230.—Mansfield, C. B., 229, 230.—Pellatt, A., 232.—Bettie, —, 231.—Stephenson, R., 232.—Whishaw, F., 232.

Liquids, fluidity of, details of some experiments on the, i. (1839) 76.

Liverpool Corporation water-works, description of the, (Duncan, T.), xii. 460.

'Liverpool' steam vessel, comparison of the power with the tonnage, i. (1841) 65.

LLEWELLIN, J. [Election, i. (1839) 80.]

LLEWELLIN, W. [Election, i. (1839) 80.]

LLEWELLIN, W., Jun. [Election, ii. (1843) 183.]

LLOYD, J. H. [Election, xx. 106.]

Water supply. Rights of property in water flowing over the surface, xx. 251.—Law of water rights, 254.

LLOYD, Lieutenant-Colonel J. A. [Election, viii. 164; Member of Council, ix., 60; Telford medal, 66; memoir, xiv. 161.]

Junction of the Atlantic and Pacific oceans. "On the facilities for a ship canal communication between the Atlantic and Pacific oceans, through the Isthmus of Panamá," ix. 58.—Remarks, 70.—M. Garella's survey, and respective lengths of the various routes, 72.—Materials of the Isthmus, 79.—Atrato route, 80.—Minerals and woods of the Isthmus, 84.—Various proposed routes, 87.

LOCKE.

Patents, desire for cheap, x. 214.

Sea-wall in a volcanic island near the Mauritius, x. 277.

LLOYD, S. [Election, xvi. 371.]

LLOYD, T. [Election, i. (1841) 140.]

Steam-vessels, propriety of all having counters on board, vii. 73.

LLOYD, W. [Election, xiii. 864.]

Lock and sluice at Ferraby, for the Ancholme drainage, iv. 195.

Lockage, description of a new system of, for canals, i. (1840) 53.

—, remarks as to the expenditure of water by the system of, illustrated by the cases of the chain of eight locks at Corpach, on the Caledonian canal, and by the Blackhill locks, on the Monkland canal, xiii. 217. *Vide also* CANALS, Incline-planes.

LOCKE, J. [Member of Council, i. (1838) 20; (1839) 27; (1840) 36; iv. 62; v. 142; vi. 46; vii. 56; viii. 44; ix. 91; x. 60; Vice President, xi. 84; xii. 112; xiii. 123; xiv. 97; xv. 76; xvi. 88; President, xvii. 70; xviii. 164; memoir, xx. 141.]

Address, on taking the chair for the first time after his election as President, xvii. 128. *Vide also* RAILWAY SYSTEMS, France.

Arches, experiments upon elliptical cast-iron, and upon the ribs for the roof of the Lime-street station, Liverpool, xviii. 361.

Artillery. Sir W. Armstrong's and Mr. Whitworth's breech-loading rifled ordnance, xix. 421.

Axle-boxes, new system of, not requiring lubrication, and without liability to heating, xviii. 416.

Beams. Experiments upon the brick beam erected at the Great Exhibition, Hyde Park, xi. 505.

Brunel, I. K., notice of the death of, xix. 1.

Cement, blocks, &c., use of, in hydraulic works, xi. 505.

Decease of, notice of the, by Mr. G. P. Bidder, President, at the opening of the Session, xx. 1.—Ditto in Annual Report, 128.

LOCKE.

- Docks, Southampton, xvii. 554.—Victoria (London) docks, xviii. 489.
- Drainage of land, legislative interference in the, xix. 86.
- Engine, Du Trembley's combined-vapour, xviii. 294.
- Fuel. Method of depriving coals of its sulphur, xii. 378.
- Iron and steel. Co-efficients of elasticity and of rupture in massive forgings, xviii. 331.—Puddled steel, 347.—Bessemer process for the manufacture of malleable iron and steel, 547.
- Locomotive engines, outside-cylinder, viii. 254.
- Machines. Martin's improved Jacquard-machine, xiii. 368.
- Mines, ventilation of, vi. 191.—Condemnation of Government interference with, 191.
- Ores, dressing tin and copper, xvii. 220.
- Permanent way, duration and cost of maintenance of, ix. 405.—Notice of the double T rail introduced by him (Adams, W. B.), xvi. 229.—Introduction of wooden keys on the Liverpool and Manchester railway, 293.—Durability of timber sleepers, xviii. 443.
- Public works in India. Reported difficulty of carrying on, xvii. 537.—Provisions which should be made by the Government of India, for supervising the execution of the railways, 538.
- Railway accidents. Sources of danger on a railway, xi. 467.
- Railway breaks, xvii. 171.
- Railway companies, advantage of, manufacturing their own rolling stock, xi. 466, 468.
- Railway stations, arrangement and construction of, and alleged superiority of those on the Continent, xvii. 482.
- Railway trains, resistances to, and experiments on inclined planes, vii. 305, 306, 309, 317, 320.
- Railways, results of experiments instituted by the British Association on, iv. 278.—Legislation as affecting British railways; difference between a county guarantee and that of a government, xviii. 48.—Report of the Committee of

LOCKS AND KEYS.

- the House of Commons for the revision of the Standing Orders, 49.
- Rivers, treatment of, xii. 20.—Chart showing improvements in the Clyde since 1842, xix. 111.—Effect of recent improvements in the Thames and the Clyde, 112.
- Roof over the Lime-street station, Liverpool, and mode of testing its strength, ix. 212; xviii. 361.—Roofing of railway stations in one span, ix. 213.—Cost of the Liverpool roof, 214.
- Stephenson, R., M.P., notice of the death of, xix. 1.
- Telegraph cables, submerging, xvii. 358.
- Tunnels; Netherton, on the Birmingham canal; Woodhead, on the Manchester and Sheffield railway; and railway tunnel at Liverpool, xix. 277.
- Viaducts, Kent and Leven, in Morecambe Bay, for the Ulverstone and Lancaster railway, xvii. 448.
- Water-meters, xvi. 64.
- Water supply of Bombay, xvii. 574.—Variation of the level of the water in chalk, xix. 51.
- Water-works, Melbourne gravitation, xviii. 403.
- LOCK-GATES.
- Sliding. "A new plan of construction of sliding gates for the entrance locks of docks, &c." By J. C. Singala, i. (1839) 78.
- Discussion.—Palmer, H. R., 79.
- Timber. "On framing lock-gates without iron work." By S. Ballard, i. (1839) 31.
- Vide also* CANALS; DOCK-GATES; DOCKS; HARBOURS, Port Talbot; RIVER LEE; and RIVER SEVERN.
- Lock-meter used in Lombardy for measuring water for irrigation (Albano, B.), ii. (1843) 200.
- Locks, *Vide* CANALS; DOCK-GATES; DOCKS; HARBOURS, Port Talbot; LOCK-GATES; RIVER LEE; and RIVER SEVERN.
- LOCKS AND KEYS.
- "On the construction of locks and keys." By J. Chubb, ix. 310.—Early history of locks, 310.—The ancient Egyptian lock, 312.—The letter lock, 313.—Locks

LOCKS AND KEYS.

with fixed wards, 316.—Locks having a single tumbler in addition to fixed wards, 317.—The Egyptian, 317.—Barron's, 318.—Bramah's, 318.—Chubb's, 320.—Calculation showing the number of combinations which may be made in ditto, 321.—Series of locks for Westminster Bridewell, 322.—Principles to be combined in every good lock, 323.—Where the manufacture is carried on, 323.—Appendix A, extracts from the 'Bankers' Magazine,' relative to mode adopted for robbing a bank, 324.—Ditto B, description of Chubb's quadruple lock, 325.—Ditto C, letter from Lieut. Tracey, as to locks at Westminster Bridewell, 326.—Ditto D, list of patents for locks and latches granted since the establishment of the patent laws, 326.—Ditto E, list of references to the 'Transactions of the Society of Arts' on the subject of locks, 328.

Discussion.—Chubb, J., 328, 337, 338, 340, 343.—Farey, J., 331, 339, 342.—Hart, C., 340.—Hodge, P. R., 336, 338.—O'Brien, Capt., 339.—Owen, —, 341.—Stephenson, R., 336, 339, 342.—Varley, C., 336.—Whitworth, J., 339.

"On the principles and construction of locks." By A. C. Hobbs, xiii. 251.—Locks having a series of fixed obstructions, or wards, 252.—Manner of making a false key to pass the most complex wards, 252.—Letter, or puzzle locks, 253.—Improvements in ditto, by Regnier, 253.—Modification of ditto for doors, or dial lock, 253.—How the letter lock can be surreptitiously opened, 254.—Locks depending for their security upon a series of moveable pieces, called slides, pins, tumblers, &c., placed within the case, 254.—Egyptian, or pin lock, 254.—Barron's tumbler lock, of 1778, 255.—Bramah's, of 1784, 255.—Cotterel's, 256.—Tumbler lock, by Bird, in 1790, 256.—Mitchell and Lawton's addition of detectors to the tumbler lock, in 1815, 257.—Chubb's detector, of 1818, 258.—Opening of these locks does not depend on ascertaining the particular

LOCOMOTIVE BOILERS.

combination in any case, 258.—Improvement in the tumbler lock, 259.—Mr. E. B. Denison's new lock, 260.—Permutation, or American bank lock, 261.—Sources of security in ditto, 262.

Discussion.—Carpmael, W., 269.—Chubb, C., 270.—Denison, E. B., 264, 268.—Goater, W., 269.—Hobbs, A. C., 263, 267, 270.—Hodge, P. R., 266.—James, J., 266.—Martin, —, 267.—Simpson, J., 271.—Whishaw, F., 268.

LOCKWOOD, P. C. [Election, xviii. 525.]

LOCOMOTIVE BOILERS.

American white cedar used for covering, (Brunel, I. K.), i. (1840) 45.

Fuels for. "On locomotive boilers and on fuels." By J. S. Sewell, xii. 432.—Steaming-powers of different fuels, 433.—Standard value of 1 lb. of various fuels, 434.—Results obtained from differently-formed boilers, and with different fuels, 434.—Table of the relative heating surface and evaporative power of various locomotive and other boilers, 436.—Details of Mr. McConnell's new engine, and of the results obtained, 436.—Position of the tubes, 437.—Gauge trials, 439.—Rapiditv of evaporation as essential as economy of fuel, 439.—Table of the draughts of steam, and the time allowed for the absorption of the heat, for different-sized driving-wheels, and different velocities, 440.—Wear of the tubes, 440.—Table of the results of some comparative trials with different engines, 441.—Power of a cubic foot of water, as steam of different temperatures, 445.—Proportion of tubular and fire-box surface may be varied, 446.—First locomotive constructed at Paris from the designs of M. Cugnot, in 1769-70, 446.—Safe strength of boilers, 446.—Cases of passenger-engines, or trains, running off the rails, 448.—Conclusions, 448.

Principles of. "Experimental investigation of the principles of the boilers of locomotive engines." By D. K. Clark, xii. 382.—Essential characteristics of a good and efficient lo-

LOCOMOTIVE BOILERS.

comotive, 383. — Physiological conditions of excellence in the boiler, 384. — Results of experiments on coals suited to the steam navy, 384. — Ditto of laboratory experiments on the evaporative power of coal, 384. — Ditto on the combustion of coke in locomotive boilers, 385. — Evaporating performance of coke, in suitably-proportioned boilers, 386. — Relative importance of the heating surface of the fire-box and that of the tubes, 387. — Table I., performances of locomotives of various proportions and dimensions, to illustrate the mutual relation of grate-area, heating-surface, and economical evaporative power, 390. — Advantage of the extension of heating-surface, 392. — Inferior economy of evaporation of the engines of the Great Western railway, 393. — Comparison of the Great Western engines amongst themselves, 394. — Results of Mr. D. K. Clark's experiments, 395. — Influence of extension upon the value of heating-surface, dependent upon the ratio of the heating-surface to the grate-area, 396. — Concentrated, rapid combustion the true practice for boilers, 398. — Formula embracing the three elements, grate-area, heating-surface, and economical evaporative power, 399. — Diagram to show the rate of economical consumption of water, per hour, per foot of grate, for given surface-ratios, 400. — Rules for finding the rate of consumption of water for a given heating-surface, and grate-area, 401. — Rule for finding the heating-surface necessary to maintain a given hourly consumption of water economically, with a given area of grate, 401. — Ditto, the grate-area suitable for maintaining ditto, with a given heating-surface, 401. — Conclusions as to the relations between heating-surface, grate-area, and economical evaporative power, 402. — Table II., economical evaporative power of locomotive boilers, for giving ratios of heating-surfaces, 404. — Table III., of

LOCOMOTIVE BOILERS.

relative grate-areas, heating-surfaces, and economical evaporative powers of locomotive boilers; deduced from practice, 404. — Rule for finding the clearance between the tubes, suitable for economical evaporation, for a given number of tubes, 405. — Table IV., of the clearance between the tubes suitable for economical evaporation, at the rate of 9 lbs. water per lb. of coke, 405. — Rule for finding the relation of the diameter of a boiler-barrel and the number of tubes which can be received by it, 406. — Ditto the diameter of barrel suited to accommodate a given number of tubes at a given pitch, 407. — Ditto the greatest number of tubes which should be placed in a barrel of given diameter, and at a given pitch, 407. — Table V., of the diameter of barrel practically suitable for given numbers of 2-inch tubes, 407. — Examples of locomotive boilers tested by principles enunciated; the 'Hecla,' 408. — Ditto, the 'Great Britain,' 408. — Ditto, the 'Liverpool,' on Mr. Crampton's system, 409. — Ditto, Mr. McConnell's new engine, 409. — Conclusions arrived at, as to the blast-pipe, and its relations to the engine and the boiler, 410.

Discussion. — Bidder, G. P., 427. — Clark, D. K., 414, 423, 427. — Crampton, T. R., 414, 424, 426. — Field, J., 416. — Hawkshaw, J., 414, 425. — McConnell, J. E., 417, 426. — May, C., 426. — Moorsom, Capt. W. S., 425. — Parsons, P. M., 426, 429. — Phipps, G. H., 425. — Playfair, Dr. L., 429. — Russell, J. S., 415. — Stephenson, R., 415, 430.

Tubes. Relation between the diameter and intermediate spaces of the tubes (Buck, G. W.), i. (1838) 51.

—. "On tubing the boilers of locomotive engines." By G. W. Buck, i. (1839) 32.

Valve springs for safety-valves of. "On the application of valve springs to the safety-valves of locomotive boilers." By J. Baillie, xv. 28. — Experiments to determine inability of present safety-

LOCOMOTIVE ENGINES.

valves, to discharge the quantity of steam generated in locomotive boilers, 28.—Ditto with a small valve, weighted with the usual lever and spring-balance, 29.—Ditto with a large valve, weighted by means of seven volute springs, 29.—Causes of explosions in locomotive boilers, 31.—Man-hole arranged as safety-valve, 32.

Discussion.—Amos, C. E., 39.—Brunel, I. K., 39.—Clark, D. K., 38.—Crampton, T. R., 41, 42.—Crocker, B. W., 42.—Freeman, J., 41.—Kreeft, S. C., 37.—Manby, C., 43.—Thomson, D., 42.

Water for, viii, 171, *et seq.*

Vide also LOCOMOTIVE ENGINES; LOCOMOTIVE STOCK; STEAM; and STEAM BOILERS.

LOCOMOTIVE ENGINES.

American, for Birmingham and Gloucester railway. "Account of a series of experiments on locomotive engines, more particularly on the 'England,' the 'Columbia,' and the 'Atlantic,' manufactured by Mr. Norris, of Philadelphia." By Capt. Moorsom, i. (1840) 45.—Details of their construction and weight, 45.—Notice of the trials made on the Grand Junction railway, 46.—Analysis of the results of ditto, 46.—Consumption of fuel in ditto, 47.

Discussion.—Bury, E., 48, 49.—Donkin, B., 48.—Moorsom, Capt., 47.—Walker, J., 49.

American, for Birmingham and Gloucester railway. "Description of the American engine 'Philadelphia,' made by Mr. Norris, of Philadelphia, North America, for the Birmingham and Gloucester railway." By G. D. Bishopp; communicated by Capt. W. S. Moorsom, ii. (1843) 99.—Length and angle of the Lickey incline, 99.—'Bogie' engine, 99.—Summary of the work done and speed attained by these engines, 100.

Discussion.—Braithwaite, F., 102.—McConnell, J. E., 102, 103.—Moorsom, Capt. W. S., 100, 103.

Amsterdam and Rotterdam railway (Conrad, Chev.), iii. 176, 177.

LOCOMOTIVE ENGINES.

Axles of, xiii. 469, *et seq.*

Coal-burning in. "On coal-burning and feed-water heating in locomotive engines." By D. K. Clark, xix. 546.—Qualifications of the ordinary locomotive boiler for combustion of coal, 547.—Methods recently introduced of admitting air above the fuel, near its surface, and amongst the combustible gases, 550.—Adaptation of large extended fire-boxes and combustion chambers, by Mr. McConnell, Mr. Beattie, and Mr. Cudworth, 550.—Ditto of existing engines, for burning coal without smoke, by simple means, independent of extensive structural alterations, by Messrs. Gray and Chanter, Mr. Dewrance, Messrs. Dubs and Douglas, Messrs. Evans and Dubs, Mr. Yarrow, and Mr. Jenkins, 551.—System of steam-inducted air currents, for admitting air above the fuel, through the sides of the fire-box, and application of the system on different railways, 552.—Other systems for the admission of air into the fire-box, 553.—Class of contrivances acting by the deflection of a body of air introduced through the doorway, upon and over the surface of the fuel, by Mr. Douglas, Messrs. Lees and Jacques, Mr. Sinclair, and Mr. Frodsham, 553.—The steam blow-pipe, or auxiliary jet, in the chimney, common to all plans for consuming coal without smoke in locomotives, 554.—Contrivances for dealing with air in bulk, usually attended by the escape of a considerable quantity of unconsumed air through the flue-tubes, and a difficulty in keeping up steam at high speeds, 556.—The various forms of doorway deflectors objectionable, in facilitating the friction of particles of coal through the tubes, and the burning of the smoke-box, unless counteracted by an internal arch, 557.—The direct and efficient combustion of coal, in the ordinary locomotive boiler, depends upon the intermixture of a plentiful but regulated supply of air with the ascending smoke, or com-

LOCOMOTIVE ENGINES.

bustible gases, at or near to the surface of the fuel, 557.—Performances of coal and coke burning engines compared, 559.—Comparison of the results of coal-burning practice on different lines, 560.—Feed-water heaters, 562.

Discussion.—Barlow, W. H., 567.—Berkley, G., 566.—Clark, D. K., 564, 566, 583.—Colburn, Z., 572.—Cowper, E. A., 580.—Fletcher, L. E., 566.—Greaves, O., 581.—Hawthaw, J., 565.—Hawksley, T., 569, 579.—Longridge, J. A., 567, 576.—Wright, A., 566.—Yarrow, T., 571.

Construction of. "On locomotive engines." By E. Woods, i. (1838) 3.—On outside and inside framing, 4.—The weight increased, 4.

—"On the construction of locomotive engines, especially with respect to those modifications which enable additional power to be gained, without materially increasing the weight, or unduly elevating the centre of gravity." By T. R. Crampton, viii. 233.—Increased power and size of engines caused the centre of gravity to be raised so high as to produce unsteadiness, 233.—Principles which should be adopted for ensuring steadiness, 233.—Inquiry as to how far these principles have been observed in, 1°, an outside-cylinder engine, whose axles are all confined within the fire and smoke boxes, 234.—Ditto, 2°, ditto, and the cylinders are placed between the small wheels, 234.—Ditto, 3°, ditto, in which the driving-axle is under the boiler, the trailing-wheels behind the fire-box, and the cylinders and smoke-box projecting beyond the leading-axle, 234.—Ditto, 4°, in a six-wheeled inside-cylinder engine, in which the distribution of the weight is similar to 3°, except that the cylinders are placed close to the leading-axle, 235.—Ditto, 5°, in a four-wheeled inside-cylinder engine, 235.—Comparison between inside-cylinder and outside-cylinder engines, 235.—Extent of heating surface in, and general dimensions and construc-

LOCOMOTIVE ENGINES.

tion of, an engine, in which the boiler is low, the driving-axle is behind the fire-box, the two smaller wheels under the body of the boiler, and the cylinder between the smaller wheels, 236.—Advantages of this form of engine, and of the employment of large driving-wheels, 237.—Means by which greater power may be introduced, with any required diameter of driving-wheels, 238.—Dimensions of the large narrow-gauge engine 'Liverpool,' 238.—Relative angles of stability of the different engines, 238.—Importance of balancing the moving parts, arrangement of a tank engine on the new principle, and necessity of attention in distributing the weights on the wheels, 239.—Main advantages of the new engines, 239.

Discussion.—Adams, W. B., 245.—Barlow, P. W., 248.—Berkley, G., 257.—Bidder, G. P., 250, 256, 258.—Brunel, I. K., 242, 252.—Crampton, T. R., 240, 245, 247, 248, 252, 253, 257, 259, 261.—Gooch, J. V., 244.—Homeraham, S. C., 257.—Locke, J., 254.—Maudslay, H., 260.—Pauley, Lieut.-Gen. Sir O. W., 254, 258.—Rennie, G., 244.—Stephenson, R., 241, 246, 247, 250, 252, 255, 258, 260.

Engines for ascending inclines, and going round curves (Moorsom, Capt. W. S.), xv. 46. *Vide also* RAILWAY CURVES; RAILWAY CURVES AND INCLINES; and RAILWAY INCLINES.

Failures and defects, analysis of 1000 cases of, occurring on the London and North-Western and subsidiary railways (Huish, Capt. M.), xi. 440.

History of, and improvements in, (Rennie, Sir J.), v. 69; vi. 20; (Field, J.), viii. 30.

London and Birmingham railway. "An account of the performances of the locomotive engines on the London and Birmingham railway during the year 1839." By E. Bury, i. (1840) 33.—Their construction, 33.—Weight of, 34.—Performances, 34.

Management of. "Practical observations

LOCOMOTIVE ENGINES

on the management of a locomotive engine." By C. H. Gregory, i. (1841) 73.—In the station, 73.—On the road, 74.—In cases of accident, 74.

Manufacture of, relative advantages of railway companies, or private firms undertaking the, xi. 463, *et seq.*

Oldham incline, experiments on, (Laws, Capt. J. M.), x. 248.

Power of. "On the comparison between the power of locomotive engines, and the effect produced by that power at different velocities." By Prof. Barlow, i. (1839) 46.—Resistances to railway trains at different speeds, 47.

Stanhope and Tyne railway, fuel and fire-boxes of, (Harrison, T. E.), i. (1837) 38.

Steam for. "On locomotive engines and the means of supplying them with steam." By J. Perkins, i. (1837) 20.

Water for. "On water for locomotive engines, and its chemical analysis." By W. West, v. 182.—Causes of incrustation of boilers, 183.—Substances present in common spring or river waters, 183.—Occasion of difference in expression of ditto, 185.—Quantity of water taken as a standard in chemical analysis, 187.—Substances deposited from natural waters, 187.—Precautions to be adopted to prevent, as far as practicable, the incrustation of boilers, 190.—Dr. Clark's patent for the use of lime-water for ditto, 190.—Selection of water for, and analysis of, 191.—Appendix, containing analyses of sixteen kinds of water, and extracts from reports thereon, 192.

Discussion. — Braithwaite, F., 208. — Brande, Prof., 202.—Cooper, J. T., 202.—Farey, J., 213.—Gooch, J. V., 195, 210.—Gordon, A., 214, 215.—Hawkshaw, J., 209.—Johnson, J. S., 207.—Lowe, G., 215.—May, C., 214.—Peto, Sir S. M., 206.—Ritterbandt, Dr., 198, 206, 210, 211.—Smee, A., 207, 209.—Stephenson, R., 206, 209, 214.—Thorold, W., 215.

'Wien-Raab' ordinary goods locomotive, xv. 44.

LOCOMOTIVE STOCK.

Vide also LOCOMOTIVE BOILERS; LOCOMOTIVE STOCK; RAILWAY, ATMOSPHERIC; and RAILWAY AXLES.

LOCOMOTIVE STOCK.

"On the improvement of railway locomotive stock, and the reduction of the working expenses." By D. K. Clark, xv. 496; xvi. 3.—Physiology of the locomotive—The Boiler—I, as to fuel, 3.—Conditions under which coal is consumed, 4.—Results of practice as to the mechanical values of fuels for evaporation, 5.—Locomotives adapted for the combustion of coke, not suited for that of coal, 5.—Experimental evidence as to the comparative mechanical values of coal and coke, 6.—Mr. McConnell's boiler, 6.—Mr. Crampton's step-grate for burning coal, 6.—Description of Mr. Beattie's coal-burning passenger locomotive 'Canute,' 7.—Particulars and summary of trials with ditto, 8.—Coke, burning engines compared with ditto, 11.—II., as to water, 12.—Necessity for a uniformly good water-supply to locomotive boilers, 13.—III., as to the area of fire-grate and heating surface, 13.—The Engine, 13.—Observations on the action of steam in the cylinder, 14.—Results obtained by Mr. C. W. Siemens, from his regenerative engines, 15.—The Carriage, 15.—Distinguishing features successively adopted in the construction of locomotive engines, 16.—Uniformity in the leading idea of a central driving axle in front of the fire-box, 16.—Functions of the wheels, 16.—Objections to Mr. Crampton's system, of placing the driving axle behind the fire-box, 17.—Revolving and reciprocating masses should be balanced in the wheels, 17.—Comparative statement of the working of three classes of express engines on the North British railway, 18.—Economy of fuel resulting from the correct equilibration of engines, 18.—Average performance of the 'Canute,' 19.—Results of the equilibration of the 'Norman,' outside-cylinder coupled goods-engine, 19.—

LOMAX.

Estimate of the economy of working expenses due to the improvements described, 20.—Average apportionment of the receipts on British railways, 21.

Discussion.—Adams, W. B., 39.—Beat- tie, J. H., 28, 30, 41.—Bidder, G. P., 36.—Braithwaite, F., 27.—Clark, D. K., 25, 30, 38.—Crampton, T. R., 30, 31, 36.—Exall, W., 34.—Kennedy, J., 22, 25.—Phipps, G. H., 25.—Robert- son, H., 31.—Slate, A., 34.—Stephenson, R., 23.—Webster, T., 35.—Woods, E., 23, 27.

Vide also LOCOMOTIVE BOILERS; LOCO- MOTIVE ENGINES; RAILWAY, ATMO- SPHERIC; and RAILWAY AXLES.

LOMAX, E. [Election, i. (1839) 66.]

Paving. "An improved mode of paving streets," i. (1841) 131.

London, atmosphere of, sal-ammoniac and muriate of ammonia always found in, i. (1839) 34.

LONDON BASIN.

"Observations on the periodical drainage and replenishment of the subterranean reservoir in the chalk basin of London." By the Rev. J. C. Clutterbuck, ii. (1842) 155.—Level of the reservoir in the chalk basin of London, 156.—Alterna- tion of ditto, 156.—Supply of, in the chalk decreases annually, 157.—Level of, gradually reduced during the work- ing days and replenished in the resting days, 157.

Discussion.—Braithwaite, F., 162, 164.—Buckland, Dr., 158, 162.—Clutter- buck, Rev. J. C., 161, 163.—Dickinson, J., 161.—Palmer, H. R., 163.

"Observations on the periodical drainage and replenishment of the subterranean reservoir in the chalk basin of Lon- don." By the Rev. J. C. Clutterbuck, ii. (1843) 156.—Reply to objections to former statements relative to, 156.—Source of the supply of water to the well at Epping, 156.—Dip of water level between the river Colne and London, 156.—Ditto depressed by the pumping in London, 157.—Desirable that the wells should be measured

LONDON BASIN.

periodically, 157.—Oscillations of the water level, 157.—Irruption of rain water by the swallow holes, 157.—Inclination of the water level, 157.

Discussion.—Braithwaite, F., 164.—Clark, T., 164.—Clutterbuck, Rev. J. C., 161, 163, 164.—Davison, R., 164.—Dickinson, J., 159.—Scanlan, M., 163.—Simpson, J., 163.

Lowering of the level of the water, and infiltration of salt water into wells, in the (Braithwaite, F.), viii. 178.

Vide also RAILWAY STATIONS, Camden.

"On some peculiar features of the water-bearing strata of the London basin." By P. W. Barlow, xiv. 42.—Opportu- nities afforded by railways for inves- tigating stratification of a district, 42.—Strata forming crust of Lon- don basin, 42.—General boundary of basin, 42.—Superficial area of forma- tion, 43.—Level of chalk below Lon- don, 43.—Lines of disturbances in chalk strata, 44.—Effect of these dis- turbances, 45.—First water-bearing stratum in descending the series, 46.—Second water-bearing stratum, 47.—Supply of water from wells at Watford, 47.—Extract from report by Mr. Ho- mersham to the London (Watford) Spring-Water Company, 48.—Ditto by Mr. R. Stephenson to the London and Westminster Water Company, 49.—Reduction of water-level under Lon- don, 50.—Mr. Dickinson's experiments for ascertaining quantity of water re- ceived into the chalk, 51.—Table showing rainfall and quantity which penetrated through surface of earth, 51.—Statement of the discharge of the river Lee, between Hertford and Field's Weir, March, 1850, 52.—South- eastern district as a source for supply of water to metropolis, 53.—Extract from Mr. Barlow's report to the direc- tors of the South Eastern railway on ditto, 53.—Ditto by Professor Ansted, on the supply of water to be obtained from the North Kent district, 55.—Effect of great transverse fault passing through Deptford, 58.—Mode of secur-

LONDON CLAY.

ing water in chalk, 58.—Plumstead water-works, 58.—Dr. Clark's softening process, 59.—Upper and lower greensand formations as water-bearing strata, 61.—Rainfall in ditto, 62.—Rise of water in Artesian wells in the greensand, 62.—Demand for, and necessity of, more copious supply of water, 64.—Extension of existing water companies' works, 65.

Discussion.—Barlow, P. W., 66, 70, 80, 88, 93.—Beardmore, N., 70, 86.—Braithwaite, F., 66, 73.—Clegg, S., Jun., 68, 84.—Clutterbuck, Rev. J. C., 66.—Dickinson, J., 71, 80, 84, 89.—Evans, J., 86.—Hakewill, P. H., 74.—Hawkshaw, J., 75, 87.—Homersham, S. C., 72, 81.—Prestwich, J., Jun., 77, 89.—Rawlinson, R., 92.—Simpson, J., 68, 93.

Vide also WATER SUPPLY, and WELLS.

London clay, account of some slips in, on the line of the London and Croydon railway (Gregory, C. H.), iii. 135.

London time, and its general adoption for railway purposes, iv. 64, 71 *et seq.*

LONGRIDGE, J. A. [Election, xv. 246; Telford medal, xviii. 174; Watt medal and Manby premium, xx. 121, 170.]

Artillery. "On the construction of artillery, and other vessels, to resist great internal pressure," xix. 283.—Remarks, 338.—Deterioration of cast iron in the interior of a gun by cooling, 340.—Pressure which would burst the cylinder of a hydraulic press, 341.—State of tension of the particles of a homogeneous cylinder strained by an internal pressure, 341.—Ordnance Select Committee, 370.—Manner in which his invention was tested, 483.—Effect of twist in rifled guns, 493.—Want of some means of adjusting the trunnions of all ordnance perfectly horizontal, 436.—Statement, that the effect of a resisting medium is to prolong the range of the shot, 440.—Actual and calculated parabolic ranges for some of the experiments made with the Armstrong and the Whitworth guns, 442.—Cast iron as a material for ordnance,

LONGRIDGE.

443.—Mixture of certain alloys, ditto, 444.—Wrought iron and steel, ditto, 445.—Building up guns with concentric rings or hoops, or binding them with wire, 446.

—Power of, and initial velocity of projectiles, xx. 500.—Captain Blakely's gun, 501.

Boilers, self-acting apparatus for, and use of fusible metal cups, xv. 294.—Effect of overheating the plates considered as a cause of boiler explosions, 294.

Breakwaters, form and construction of, and classes of waves to which sea works are exposed, xix. 655.

Fuel. Comparative heating powers of coal and coke, xix. 568, 576.—Heat generated by 1 lb. of coal, and by 1 lb. of coke, 568.—Quantity of air required for the perfect combustion of 1 lb. of Hartley coal, 577.—Results of ten experiments on Hartley coal, tending to show that the admission of air, in such quantity as was required to prevent smoke, was to increase the temperature of the chimney, and to decrease the consumption of fuel, 578.

Girders, construction of iron, xix. 348.

Gunpowder, force of, xix. 437.

Locomotive engines, coal-burning in, particularly the plan introduced by Mr. Hall, of Basford, xix. 567.

Mines. Partial lighting with gas of the Seaton Delaval and the Townley collieries, and difficulties of bringing gas into the workings of coal-mines, xvii. 11.—Condition of the explosive gases in coal-seams, 12.

Railway, Calcutta and South Eastern, xix. 620.

River Muttla, capabilities of, for the formation of a new port, xix. 620.

Smoke, experiments upon the consumption of, xix. 567, 577.—Ditto, on board the 'Bustler,' showing the advantage of the use of ventilating doors, 578.

Steam. Experiment to prove the possibility of surcharged steam being in contact with water, xv. 295.—Economy in the use of superheated steam, xix.

LONGSDON.

468.—Temperature of the gases in the up-take before the chimney, in a marine boiler, as ascertained during experiments relative to the consumption of smoke, and application of a heater for abstracting a portion of the heat, 469.

Steam boilers, explosions of. Development of hydrogen is the cause of, xv. 295.—Relative influence of internal flue-firing and under-firing, 296.

Telegraph cables. Methods proposed for catching a submarine telegraph cable in case of fracture, xvii. 300.—Submerging of telegraph cables, 341.—Law of a body sinking in a resisting medium, and difference between a series of balls and a telegraphic cable, 341.—Tension in paying out a cable, 348.—Diminution of tension arising from letting the cable run out quicker than the rate at which the vessel moves, 344.—Action of currents, 345.—Stopping the paying out, or attempting to haul in the cable, 345.—Effect of the pitching of the vessel, 346.—Paying-out apparatus, and plan proposed embodying 'picking-up' chains, 346.—As to catching the ends of the cable in case of fracture, 348.—Construction of the cable, 348.—Means of diminishing the tension, and forces affecting the result, 362.—Angle made by the cable with the horizon, on leaving the ship, 363.—Resistance of the water to a cable falling through it, 364.—Electric cable between Malta and Alexandria, xx. 502.

Water. Opinion of Mr. R. Hunt as to spheroidal form assumed by water, xv. 295.

Waves in the Atlantic ocean, height of the, xvii. 346.

—, and Brooks, C. H.

Telegraph cables. "On submerging telegraphic cables," xvii. 221.

LONGSDON, A.

Artillery. Circumstances in connection with the bursting of Mr. Krüpp's gun, at Woolwich, in 1853, xix. 343.

LOVEGROVE, J. [Election, xix. 461.]

LOVELACE, the Right Honourable the Earl

LOWE.

of. [Telford medal, viii. 5; election, 206.]

Harbours of refuge. "On harbours of refuge," vii. 366.—Remarks, 410.

Roofs. "On the construction of a collar roof, with arched trusses of bent timber, at East Horsley Park," viii. 282.—Remarks, 284.—Advantage of taking off the strain from the top of the walls, 284.

LOVICK, —.

Drainage of towns. Failure of pipe sewer at Kilburn, xii. 69.

Low Moor iron, converted into steel, ii. (1843) 86.—Ditto boiler-plate preferable for ship-building, 175.

LOWN, G. [Member of Council, i. (1837) 15; (1838) 20; (1839) 27; (1840) 36; (1841) 52; ii. (1842) 51; (1843) 67; iii. 66; iv. 62.]

Air, proportion of the constituent parts of, extracted from water, iv. 332.

Anthracite, use of, i. (1841) 154.

Brickmaking, ii. (1843) 153.

Cements, formation of, i. (1837) 19.

Cuttings and embankments. Landslip in Ashley cutting, iii. 133.

Fuel, use of peat, i. (1839) 29, 31.—

Resin fuel, 85.—Analysis of coal, 36.—

Coke as fuel, 40, 42, 60.—Coke ovens, 40.—Straw coke, 67.

Furnaces. Clearing furnace-bars of clinkers, and admission of air to, xiv. 18.

Gas, purification of, iii. 301.

Gas-pipes, vibrations of a pressure gauge attached to a line of, i. (1841) 151.—Porosity of, iii. 304.—Leakage of, iv. 220.

Gas-regulators, i. (1840) 61.

Iron, smelting, ii. (1842) 61.—Changes produced in wrought-iron fire-bars, 182.—Making iron, ii. (1843) 128.—Changes induced in cast iron, by immersion in various fluids, iv. 333.

Landslips, i. (1840) 36.

Light, experiments on intensity of, i. (1840) 25.

Liquid hydrocarbons. Practical uses, for the purposes of illumination, of a new class of highly volatile hydrocar-

LOWERING BOATS.

- bona, viii. 228.—Naphthalizing coal gas, 229, 230.
- Metals, corrosion of, i. (1839) 34.
- Mirrors, banding discs of silvered plate-glass into concave, or convex, i. (1840) 82.
- Pump valves, iii. 94.
- Railway, atmospheric, friction of the air in the tube of the, iv. 284.
- Steam boilers, different means of preventing the incrustation of, v. 215.
- Timber, Kyanizing, i. (1841) 91.—Use of coal-tar pitch, ii. (1842) 67.
- Water, decomposition of, i. (1838) 46.
- Lowering boats, Clifford's system of, xiv. 418.
- LOWTHER, Lord Viscount. [Election, i. (1838) 24.]
- LOYSEL, E. [Election, xiv. 374.]
- Hydrostatic percolator, for extracting colouring matters from dye-woods, for obtaining infusions, or extracts of vegetable substances, and for medicinal or other purposes, xiii. 416.
- LUBBOCK, J. W. [Election, i. (1839) 46.]
- Steam. "A theoretical calculation of the fuel saved by working steam expansively," i. (1840) 8.
- LUCY, —.
- Engines. Substitute for the fly-wheel invented by, (Parkes, J.), ii. (1842) 113.

LYSTER.

- LUKIN, A. S. [Council premium, xvii. 80.]
- Bridges, suspension, xvi. 458, 473.
- , and CONDEE, C. E.
- Bridges, suspension. "On the disturbances of suspension-bridges, and the modes of counteracting them," xvi. 458.
- LULOFF, —.
- Coasts, &c. Reference to his treatise on the elevation of the sea, and the depression of the land on the coast of Holland (Conrad, F. W.), ii. (1842) 173.
- LUSHINGTON, Captain S., R.N. [Election, iv. 291.]
- LYELL, Sir C.
- Coasts, &c. Effect of recent storms on Hurst Point and Chesil-bank, xi. 205.
- LYNDE, J.
- Permanent way. Trenails used on the Hull and Selby railway, ii. (1842) 79.
- LYNDEHURST, Lord. [Election, ii. (1842) 184.]
- LYON, G. [Election, xvii. 195.]
- LYSONS, Colonel.
- Defences, national, particularly whether the country should be defended by fortifications upon land, or by a Channel fleet alone, or by a combination of the two; and, if so, in what proportion, xx. 450.
- LYSTER, G. F. [Election, xviii. 72.]

M.

MACADAMIZED ROADS.

Macadamized roads, on, for the streets of towns (Smith, J. P.), xiii. 221.

McCLeAN, J. R. [Election, i. (1839) 87; Member of Council, vii. 56; viii. 44; ix. 91; x. 60; xi. 84; xii. 112; xiii. 123; xiv. 97; xv. 76; xvi. 88; Vice-President, xvii. 70; xviii. 164; xix. 132; xx. 108.]

Bridges. Dimensions of cast-iron girders at Perry Bar bridge, and the towing-path bridge at the junction of the Birmingham and Fazeley canal, on the line of the Tame Valley canal, iv. 247.

Drainage of towns. His competition plan submitted to the Commissioners of Sewers, in 1849, for the sewerage of the metropolis, xiii. 83. — Capt. Vetch's plan, 85. — Mr. Frank Forster's plan, 85. — Mr. Bazalgette's plan for the north side of the Thames, 86. — Instructions of the Commissioners, as to the drainage of the north side of the Thames, 86. — Capt. Vetch's plan, at variance with these instructions, 86. — Effect of an alteration of the level of the main outfall, 86. — Report of the Commissioners on his plan of crossing the Thames, 87. — Proposed sewer south of the Thames, 87. — Delivery of the sewage matter at a greater distance down the Thames, or even to avoid the river entirely, 87.

Railway embankments. Barrow and Piel sea embankments of the Furness railway, vii. 201.

Tides. Suggestion for an uniform datum for tidal reference, all round the coast of England (Parke, W.), v. 309.

Water, friction of, in pipes, xiv. 310.

McCLNERY, —.

Rivers. Fall and other particulars of the Lower Bann, vii. 287.

McCONNELL, J. E. [Election, iv. 186.]

Fuel, combustion of. Means of admitting air into a fire-grate, v. 368.

MACDONNELL.

Locomotive boilers. Results obtained with his new locomotive engine boiler, xii. 426.

Locomotive engines, American, ii. (1843) 102, 103, 104. — Experiments with dilute sulphuric acid, for preventing priming in locomotive engines, supplied with water from the well at the Camden station, viii. 178. — Actual working results of locomotive engines, compared with deductions from Mr. D. K. Clark's formula, xii. 417. — Objections to long tubes, 419. — Intense combustion liable to cause the formation of clinkers in the small fire-box, but not in the new engine, 420.

Railway breaks. Description of an improved break, ii. (1843) 104.

Steam navigation, &c. Results of the working of the Chester and Holyhead railway Company's steam-vessels, xvi. 345.

McConnell's (J. E.) locomotive boiler, with large fire-box, mid-feathers, and combustion chambers, results of the combustion of coal and coke in, xvi. 6.

— — steam break, xix. 491.

— — system of coal-burning in locomotive engines, xix. 550.

McConnochie's cast-iron wedge-chair, xvi. 235.

McCORMICK, W. [Election, xii. 109.]

MACDONALD, —.

Bridges. His patent railway bridge (Manby, C.), iii. 64.

MACDONNELL, J. J. [Election, ix. 183.]

Turn-table. "Description of a turn-table, 42 feet in diameter, in use on the Bristol and Exeter railway," x. 245.

Macdonnell's (J. J.) longitudinal iron for bridge rails, xvi. 249; ditto, continuous rolled-iron permanent way, as laid on the Bristol and Exeter and on the Bridport railways, with the cost

McDOUGAL.

of different sections, and experiments on the vertical stiffness of rails and rail-bearers, xx. 261, *et seq.*

McDougal's fluid for deodorising liquid sewage, xx. 234, *et seq.*

McDowall's cross-cut saw, at the Royal Arsenal, Woolwich, xvii. 24.

M'Ewen, R.

Steam boilers, explosion of. "Description of an apparatus for preventing the explosion of steam boilers," i. (1840) 55.

Machines for joining lead and other pipes, xviii. 405.

MACHINERY.

Bearings for, composition of, (Braithwaite, F.), iii. 88.

Conversion of iron. "Description of the machinery and the several processes for converting refined metal into malleable finished iron at the Rhymney works." By J. Richards, i. (1839) 49.

Conversion of wood. "On the conversion of wood by machinery." By G. L. Molesworth, xvii. 17.—Saw-mills, actuated by water-wheels and by the vanes of windmills, existed at a very early date, 17.—Circular saws of doubtful origin, 17.—First idea of a planing-machine, 17.—Improvements introduced by Bentham and Brunel in machinery for the conversion of timber, 17.—Successive patents for the band-saw, 18.—Labour-saving machines, especially for the conversion of wood, more extensively adopted in America than in England, 19.—Instances of the subdivision of work in America, mentioned in Mr. Whitworth's report, 19.—Machinery becoming gradually more used in England, 20.—Characteristics of American machines lately imported, particularly the composition of an alloy for the bearings, mode of forming the bearings, method of securing steadiness in high-speeded shafts, the adjusting axle-box, construction of the wooden pulleys, and use of wooden framing, 20.—Silent friction-pall, for giving motion to the timber, in reciprocating

MACHINERY.

sawing, 21.—Muley saw introduced in the United States, 21.—Revolving wedge for relieving the saw of the friction of the wood, 21.—Circular saws as used in America, thickness, number of teeth, and speed, 22.—Circular saw for cutting veneers, 22.—Method of cutting veneers in Russia and in France, 22.—Forms of saw-teeth, 23.—Appliances for cross-cutting large balks, 23.—Mr. McDowall's cross-cut saw, at the Royal Arsenal, Woolwich, 24.—Cross-cut saw used in Ransome and May's railway-key and trenail machinery, 24.—Reciprocating scroll-saw, superseded by the band-saw, for cutting out curved forms, 24.—Novelties in the band-saw introduced by Mr. Ezall, 25.—Mr. Hamilton's saw, for cutting ship-timber, in curved forms, 25.—Mr. Green's method of ensuring accuracy of variable bevel, in this sawing-machine, 25.—M. Normand's saw for cutting out ship-timbers, 26.—Planing-machines, 26.—Principle of the common carpenter's plane, 26.—Machine with fixed cutters, 27.—Reciprocating planing-machine, 27.—Planing-machines with cutters revolving on a horizontal axis, 27, 28.—Mode of determining the angle of the cutters, 27.—Planing-machine with cutters revolving on a vertical axis, 28.—American machine on this principle, 29.—Socket-plane for producing cylindrical work, 29.—Moulding machines, 30.—American shaping and tenoning machine, 30.—Methods for turning irregular forms, 30.—Mr. Hughes' machine for planing the spokes of wheels, &c., 31.—Mr. Jordan's wood-carving machinery, 31.—Railway-key machine, 31.—Description of the manufacture of Ransome and May's compressed keys and trenails, 32.—Oar-machine in Chatham Dockyard, 33.—Dovetailing machines, 34.—Augers in general use, 34.—Mortising machines and chisels, 34.—Mr. Hookey's method of bending ships' timbers, 36.—Mr. Meadows' method of bending veneers, 36.—Mr.

MACHINERY.

- Blanchard's mode of bending timber, 36.—Manufacture of casks by machinery, 37.—Apparatus in use in Deptford Dockyard, for cutting tonguers and doublets, 37.—American method of cutting up the blank for dry casks, 37.—Jointing the staves, or cutting the edges to the proper bevil and curve, 38.—Mr. Robinson's and Mr. Green's methods of backing and hollowing, 38.—Mr. Rosenberg's and Mr. Robertson's methods of trussing, or bending, and putting the staves together, 38.—Processes of chining and crozing, 39.—Depreciation and wear and tear of wood-working machinery, 39.
- Discussion.—Dineen, T., 47.—Green, G., 44, 46.—Hemans, G. W., 42.—Holmes, —, 46.—Jordan, T. B., 40.—May, C., 43.—Molesworth, G. L., 49.—Owen, L. D., 47.—Ransome, A., 42.—Vigers, —, 48.—Wilson, J. W., 40.—Worsam, S., 45.
- Diving-bell. "On the machinery used for working the diving-bell at Kingstown harbour, Dublin." By P. Henderson, ii. (1842) 148.—Quantity of work done per day, 148.
- "Description of the machinery for working the diving-bell, used for setting the masonry under water, at the extension of the pier at Kilrush, in the river Shannon." By W. Vanderkiste, v. 245.
- Discussion.—Jones, Sir H. D., 247.—Rennie, Sir J., 248.—Walker, J., 248.
- Gold extracting, xv. 59, *et seq.*
- Improvements in (Rennie, Sir J.), v. 49; vi. 25; (Field, J.), vii. 36.
- Iron dock-gates of Sevastopol, machinery used in their construction (Shears, W.), vi. 47.
- London and Blackwall railway. "Description of the machinery erected by Messrs. Maudslay, Sons, and Field, at the Minories station, for working the London and Blackwall railway." By A. J. Robertson, v. 148.—General sketch of the line, and of the system upon which it is worked, 148.—The machinery, 148.—Water tanks for sup-

MACHINERY.

- plying the condensers of the large engines, 148.—The boilers and boiler-house, 149.—Dimensions of principal parts of engines, 150.—The rope, 153.—The engines and machinery at Blackwall, 155.
- Discussion.—Bidder, G. P., 156, 158.—Farey, J., 155, 157, 158.—Homersham, S. C., 157.—Stephenson, R., 156, 158.—Walker, J., 158.—Wightman, A., 159.
- Rope-making. "On Captain Huddart's improvements in rope machinery." By W. Cotton, i. (1838) 1.
- "On Huddart's rope machinery." By E. Birch, i. (1838) 39.
- "Description of a machine for sewing flat ropes." By E. Birch, i. (1841) 171.—The strength of, 171.
- Rotating chambered breech fire-arms, machinery used in the manufacture of, (Colt, Col. S.), xi. 80.
- Self-acting apparatus, danger, or otherwise, of using, (Pole, W.), xv. 237; (Hall, W. K.), 306.
- Shearing, punching, &c. "On shearing, punching, riveting, and forging machinery." By T. S. Sawyer, xvii. 173.
- "On the self-acting tools employed in the manufacture of engines, &c." By T. S. Sawyer, 176.—Machines employed in the construction of engines, 176.—Drilling and boring machines, 176.—Radial drilling machine, 177.—Cross-boring machine, 178.—Machine for operating upon large cylinders, air-pipes, &c., 178.—Turning lathes, &c., 180.—Shaping, slotting, and grooving machines, 181.—Planing machines, 181.—Machinery employed in the construction of manufacturing machines, 183.—Results of the introduction of labour-saving, or self-acting tools, 184.—Appendix, detailed descriptions of the different machines, 185.—Machine for shearing and punching holes in boiler-plates, &c., 185.—Multifarious punching machine, 185.—Circular shearing machine, 185.—Punching and shearing machine, 185.—Riveting machine, 186.—Steam riveting ma-

MACHINES.

chine, 186.—Rivet-making machine, 186.—Break, or gap-lathe, 186.—Boring mill and large lathe, 187.—Duplex turning lathe, 187.—Machine for drilling, boring, cutting keyways and cotter-holes, 187.—Improved drilling bit, 188.—Planing machine, 188.—Small planing machine, 188.—Large planing machine, 188.—Large screw-cutting lathe, 188.—Transverse and curvilinear planing and shaping machine, 189.—Screw-bolt machine, 189.—Large planing machine, 189.—Radial drill, 189.—Slotting and shaping machine, 190.—Lathe for turning large surfaces, 190.—Drilling machine, 190.—Boring and drilling machine, 190.

Discussion.—Batho, W. F., 191.—Humphrys, E., 192.—Manby, C., 191.—Maudslay, H., 193.—Ransome, A., 194.—Stephenson, R., 192.—Whitworth, J., 192.

Theatre. "Description of Stephenson's theatre machinery." By J. B. Birch, i. (1841) 153.

Vide also MACHINES, and METALS.

MACHINES.

Bending and setting tire bars. "A machine for bending and setting the tire of railway carriage wheels." By J. Woods, i. (1841) 99.

Chain cable testing. "On chain cable and timber testing machines." By T. Dunn, xvi. 301.—Table showing the comparative strength of hemp and chain cables, weight per fathom, proof to which cables are tested, weight of anchors, and register tonnage of vessels, 301.—Description of a new direct-acting hydraulic machine, 302.—Results of the testing of different chains and bars, 303.—Experiments on the strength and resistance of various woods, 304.—Ditto for ascertaining the strength of the tension-rods of the travelling-cranes intended to be used in the construction of the tubular bridge over the river St. Lawrence, 306.

Discussion.—Dunn, T., 307.—Napier, J. R., 308.—Naylor, W., 307.—Rennie, G., 307.

MACHINES.

Counting machines (Oldham, T.), ii. (1842) 167.

Friction of moving parts in large and powerful machines, and application of oil to diminish it (Farey, J.) vi. 248, 249.

Hammer, single, or double acting, (Naylor, W.), xvi. 307.

Improved Jacquard. "Description of Martin's improved Jacquard-machine." By E. Laforest, xiii. 365.

Discussion.—Hawkshaw, J., 369.—Lane, F., 368, 369.—Locke, J., 368.—May, C., 369.—Newton, W., 368, 369.

Pile-driving. "Description of the pile-driving machine used at the Montrose harbour works." By J. Milne, iii. 197.—Application of steam power, 197, 200.—Ditto, at the London and the Hull docks, 201.

Discussion.—Clarke, T., 201.—Cubitt, W., 200.—Giles, F., 200.—Green, J., 200.—Hartley, J. B., 200.—Milne, J., 200.—Rendel, J. M., 200.—Rennie, G., 201.—Vignoles, O., 201.

Printing. "On printing machines, especially those used for printing 'The Times' newspaper." By Prof. E. Cowper, ix. 409.—Nicholson's patent of 1790, 409.—Koenig's patent, in 1811, for improvements in the common press, 410.—Donkin and Bacon's machine, in which the types were fixed on a revolving four-sided prism, 411.—Koenig's patent of 1815, 411.—Cowper's patent for curving stereotype plates and fixing them on a cylinder, 412.—Ditto for printing both sides of the sheet from type, 413.—Napier's press, 415.—Applegath and Cowper's machine, erected at 'The Times' office in 1827, 415.—Applegath's vertical printing machine, 417.—Statistics relative to 'The Times', 426.

Refrigerator. "A refrigerator, or machine for cooling brewers' wort." By R. Davison, i. (1841) 57.—Experiments as to the loss by evaporation, 57.

Sawing. "Description of a sawing machine for cutting off railway bars." By J. Glynn, i. (1839) 51.

MACINTOSH.

Sawing, plank frame for. "An improved plank frame, for sawing deal planks of various thickness into any number of boards." By B. Hick, i. (1841) 97.

Stone-boring, Hunter's, (Carnegie, Capt. W. F. L.), ii. (1842) 148.

Stone-planing, Hunter's, (Carnegie, Capt. W. F. L.), i. (1837) 38.

Vide also MACHINERY, and METALS.

MACINTOSH, A. [Election, i. (1840) 22.]

MACINTOSH and Co., Messrs.

India-rubber, durability of vulcanized, when immersed in water for a long period, xiii. 483.

McINTOSH, D. [Memoir, xvi. 162.]

MACINTOSH, J.

Telegraph cables. Rise and fall of the stern of the paying-out vessel a source of disaster to submarine cables, xvii. 327. — Compensating apparatus, for superseding the necessity of releasing the breaks, 328, 329. — Construction of the cable, and insulation of the conducting wires, 328.

MACKAIN, D. [Election, i. (1840) 28; Telford premium, iii. 6; memoir, xix. 175.]

Iron. Quality of Scotch hot-blast iron, ii. (1843) 132.

Water. "On the supply of water to the city of Glasgow," ii. (1843) 134. — Appendix, description of a cast-iron reservoir erected at Garnet-hill, by the Glasgow water-works company, 139. — Consumption of water at Glasgow, xii. 504.

MACKENZIE, W. [Memoir, xi. 102.]

McKenzie and Wentworth's breech-loading rifles, xix. 461.

McKERRIE, Captain J. G., R.E. [Election, x. 192.]

M'KIE, H. U. [Election, xviii. 296.]

MACKWORTH, H. F. [Election, xii. 520; memoir, xviii. 196.]

Machine for washing coal, and its application for dressing ores, xvii. 213.

Mines. Determination of the quantity of air to be supplied to mines, xii. 297, 308, 309. — Minimum quantity consistent with health, 297. — High temperature of, and absence of ventilation

MACNEILL.

in, the deep Cornish mines, 298. — Motive power of ventilation by rarefaction, 298. — Biram's anemometer, and as to measuring the velocity of air in mines, 300. — Ventilation of mines by means of the furnace, 301. — Ditto by Struve's ventilator, 302. — Relative efficiency of several mechanical powers, 303. — Water-blasts used in blowing small iron furnaces in Germany, and for ventilating mines, 303. — Neglect of the proper distribution of the air in coal mines, 304. — Natural ventilation of collieries in winter time, 304, 309, 310. — Safety lamps, 304. — Preventing explosions in collieries, 305. — Precautions against after-damp, 305. — Government inspection of mines, 310.

McLANDSBOROUGH, J. [Election, xv. 281.]

McLANDSBOROUGH, W. [Election, xviii. 525.]

MACLEAN, Commander, R.N.

Junction of the Atlantic and Pacific oceans. Letter relative to the Isthmus of Panama (Smith, T. M.), ix. 81.

MACLEOD, Lieutenant-General D. [Election, ii. (1842) 56; memoir, xvi. 163.]

M'MASTER, B. [Election, xvi. 371.]

Permanent way. "On the permanent way of the Madras railway," xviii. 417.

MACNAIR, A. H. [Election, xvii. 52.]

MACNEILL, Major-General W. G., U.S. [Election, xi. 477; memoir, xiii. 140.]

Civil engineers of England and America, xi. 67.

Fire-arms, Colt's repeating, xi. 66.

Permanent way, mode of laying, in the United States, &c., xi. 475.

MACNEILL, Sir J. [Member of Council, i. (1837) 15; (1838) 20; (1839) 27; (1840) 36; (1841) 52; ii. (1842) 51; (1843) 67; v. 142; vi. 46; Telford medal, i. (1838) 8.]

Blasting under water. Tamping, i. (1838) 34.

Bridges, timber, decay of, i. (1841) 91.

Canal-boats, experiments on towing, by a locomotive engine (Bendel, J. M.), xiii. 212.

Lighthouses, revolving lenses in, i. (1840) 25.

M'VEAGH.

- Mirror, pneumatic, i. (1840) 33.
 Pentagraph, Professor Wallace's, i. (1839) 65.
 Railway sections; method of laying down so as to show at one view the position of the cuttings and embankments, i. (1837) 36.
 Railways. South-Eastern, ii. (1842) 78.
 — Dublin and Drogheda, 78.
 Sea defences. Use of sea-weed and peat sods in the formation of, i. (1841) 132.
 — Works at the Helder, ii. (1842) 128.
 Steam boilers, explosion of the, of the 'Union' Steam Packet at Hull, i. (1838) 41.
 Surveying instruments. His effort to dispense with the artificial horizon, by attaching a small spirit bubble to the sextant (Pole, W.), xi. 24.
 Viaducts. "Description of the Calder viaduct, on the Wishaw and Coltness railway, with the specifications, estimates, and a series of experiments to ascertain the deflection of two of the strutted beams," ii. (1842) 189.
 M'VEAGH, J. [Election, xviii. 72.]
 Madras, surf at, vi. 127.
 'Magicienne' frigate, cast-iron protector tried, iii. 87.
 Magnetism, vi. 26.
 — has no influence on the corrosion of iron ships, ii. (1843) 177.
 MAINGY, R. A. [Election, i. (1841) 129.]
 MAKINSON, A. W. [Election, xviii. 231.]
 MALCOLM, Sir C.
 Rainfall on the Malabar coast of India, vii. 282.
 MALINS, W. [Election, xiv. 491.]
 MALLETT, R. [Election, i. (1839) 49; Telford medal and premium, i. (1841) 8; Walker premium, ii. (1842) 9; iii. 7; Council premium, x. 66; Telford medal xix. 155, 193.]
 Axle-boxes, description of his patent, vi. 496.
 Blasting under water, facilities given by galvanic firing to, xv. 339.
 Bridges. "Description of the insistent pontoon bridge at the Dublin terminus of the Midland Great Western railway of Ireland," ix. 344.

MALLETT.

- Iron. "On the corrosion of cast and wrought iron in water," i. (1840) 70.
 — "On the coefficients, T_e and T_r , of elasticity and of rupture in wrought iron; in relation to the volume of the metallic mass, its metallurgic treatment, and the axial direction of its constituent crystals," xviii. 296.—Remarks, 331.—Coefficients representing the 'work done' by tension and by pressure, 331.—Defects in large wrought-iron forgings, 343.—Accidents to screw and paddle shafts in the Peninsular and Oriental Steam Navigation Company's fleet, 344.—Forgings for large guns, 346.—Puddled steel, 346.
 Metals, corrosion of. "On the action of air and water, whether fresh or salt, clear or foul, and at various temperatures, upon cast and wrought iron and steel," ii. (1843) 171.
 Railway, atmospheric. Plans for atmospheric propulsion, proposed in the year 1842, iv. 290.
 Roofs. "Description of the methods adopted for raising and sustaining the sunken roof of St. George's Church, Dublin," i. (1841) 92.
 Sea-walls, construction of, whether vertical, or sloped, xviii. 112.—Hollow trough, excavated by the action of the sea, along the base of the wall of the Commercial Wharf, Kingstown Harbour, 112.—Effect of the sudden propagation of impulse, due to the stroke of waves, acting through and within the uncemented joints and fissures of marine stone-work, in dislodging the blocks, illustrated in the case of the failure of the sea-walls of the Dublin and Kingstown railway, 113.
 Ships. "A description of a new arrangement for raising ships of all classes out of water for repair; proposed to replace the graving-dock, or the patent slip in certain situations; with observations upon the other methods used at different periods for this purpose," ii. (1842) 135.
 Ships and steam vessels. State of the 'Vanguard' iron vessel after striking on

MANBY.

the rocks in the Cove of Cork, iv. 306.

Water-wheels. "An experimental inquiry as to the coefficient of labouring force in overshot water-wheels whose diameter is equal to, or exceeds the total descent due to the fall; and of water-wheels moving in circular channels," ii. (1843) 60.—Remarks, 65.—Reply to the objections against his experiments on water-wheels, 65.

— Coefficient of water-wheels, and their velocity, iii. 67.

MANBY, A.

Ships and steam vessels. Builder of the first iron steam vessel, at Horseley, in 121, (Wilkinson, J. J.), ii. (1842) 168; (Manby, C.), (1843) 180; (Rennie, Sir J.), iv. 181.—Account of the first voyage, 184.—Steam tug constructed by him, v. 89.—Steamer with oscillating engines constructed by him, 89.—Patent for ditto, 93.—Iron vessels introduced by him (Rennie, Sir J.), 96.

MANBY, C. [Auditor, i. (1839) 27; Secretary, i. (1840) 36; (1841) 51; ii. (1842) 51; (1843) 56; iii. 57; iv. 48; v. 142; vi. 46; vii. 56; viii. 44; ix. 132; x. 126; xi. 146; xii. 205; xiii. 184; xiv. 188; xv. 122; xvi. 187; xvii. 127; xviii. 230; Honorary Secretary, xix. 213; xx. 190; Telford medal, iv. 3.]

Air engines. "On the caloric engine," xii. 558.

Aqueducts, ancient and modern, xiv. 223.

Breakwaters. M. Bonnin's treatise on the breakwater of Cherbourg; the construction and employment of concrete blocks, and their cost, xvi. 445.

Bridges. Drawing of Macdonald's lattice railway bridge, iii. 64.—Ditto of a projected bridge at Rochester, 65.—Translation of the "Description of the method adopted in preparing the foundation, and in building the bridge over the Poldevaart, on the line of the Amsterdam and Rotterdam railway," by the Chevalier F. W. Conrad, vi. 149.—Mr. Fairbairn's reasons in preparing a paper on the Torksey tubular bridge, for not taking into account the

MANBY.

continuity of the girders, and for placing implicit confidence in the formula made use of, ix. 275.—Analysis of the reports of the inspecting officers to the commissioners of railways, and of the correspondence between the Board of Trade and the engineer of the railway on which the Torksey bridge is situated, 276.—Records of experiments on the bridge itself, to test the results of the theoretical investigations, 282.—Table of deflection, showing the calculated and the actual deflection, and the difference between them, 284.—Railway suspension-bridge above the Falls at Niagara, xiv. 459.

Canals. Translation of "The history of the canal of Katwyk (Holland), with a description of the principal works," by the Chevalier F. W. Conrad, ii. (1842) 172.

Decimal coinage, &c. Visit of M. Vinsac to this country, at the time of the Exhibition of 1851, to induce the British authorities to adopt the French metrical system of weights, measures, and coins, xiii. 336.

Drainage of towns. Particulars of the main features of the sewerage of Hamburg, as designed by Mr. W. Lindley, xiii. 79.—Application of liquid manures, 118.

Fire-arms. Communications from Col. Chalmer, R.A., as to practice with Colt's revolvers, xi. 58.

Fire-proof buildings. Communication from Mr. Chubb, as to the construction of strong-rooms and fire-proof safes, viii. 154.

Fluids, elastic. Letter from M. Regnault, as to experiments on the effects of heat on elastic fluids, xii. 591.

Foundations. Col. Goodwyn's account of the method of obtaining foundations in Bengal, xvi. 455.

Gold. Memorandum of the results by assay of samples of gold-bearing slabs brought from the neighbourhood of North Molton, Devonshire, xv. 73.

Locomotive engines. Extracts from letter of Mr. J. Baillie, as to applica-

MANBY PREMIUM.

tion of volute springs to engines on the Hungarian and Austrian lines, due and proportionate loading of the springs under an engine, and reasons for employing heavy engines for the conveyance of passengers, xv. 43.—Description of the 'Wien-Raab' ordinary goods locomotive engine, 44.

Mines. Notice of Mr. Biram's anemometer, of his miner's lamp, and of some specimens of the aneroid barometer, viii. 137.—Mine ventilator at the Gelly Gaer colliery, as designed by Mr. W. Brunton, x. 55.

Propellers. Griffiths' screw propeller, xiv. 415.—De Bergue's propelling apparatus, 415.—Walduck's propellers, 416.

Railways. Translation of the "Account of the railway from Amsterdam to Rotterdam, and of the principal works upon it," by the Chevalier F. W. Conrad, iii. 173.

Ships and steam vessels. Durability of iron vessels, ii. (1843) 180.—Putting together and working of the engine on board the first iron steamer (Rennie, Sir J.), iv. 184.

Steam navigation, &c. Rev. Dr. Scoresby's investigations into the altitude and strength of waves, and his opinion on large ships for long ocean voyages, and the proportions of ships in connection with their rate of sailing, xiii. 55.

Telegraph cables, Messrs. Shepherd and Button's submarine, xi. 379.

Testimonial presented to him, xvi. 479.

Timber, Jarrah, of Western Australia, ix. 40.

—, and BRAMAH, F., Jun.

Blasting under water. "Account of the firing of gunpowder under water, by the voltaic battery, at Chatham, March 16, 1839, under the direction of Colonel Pasley," i. (1839) 50.

Manby Premium, resolution establishing a, xvii. 70.

— Testimonial, account of the proceedings on the occasion of the presentation of the, and at the following dinner, with balance-sheet and list of subscribers, xvi. 479.—Presentation of

MANSFIELD.

the, noticed in the Annual Report, xvii. 87.

MANBY, E. O. [Election, i. (1840) 26.]

MANBY, J. [Election, i. (1840) 31.]

MANBY, J. L. [Election, iii. 284.]

Manchester, Committee for Prevention of Boiler Accidents, statistics of explosions obtained by, xv. 289.

Manganese used in making steel, ii. (1843) 85.

MANNING, R. [Election, xviii. 72.]

Drainage of land. Arterial damage works in Ireland, xix. 119.

MANNIX, J. B. [Election, xiv. 418.]

MANOMETER.

"Description of a new metallic manometer, and other instruments for measuring pressures and temperatures." By E. Bourdon, xi. 14. — Instruments in ordinary use for ascertaining pressure of atmosphere, and for measuring pressure of steam and other fluids, 15.—Means proposed by M. Conté for ascertaining pressure of atmosphere, 15.—Principle of aneroid barometer, 15.—Pressure gauge proposed on ditto, 15.—Application of flattened metallic tubes to construction of pressure-gauges, barometers, &c., 15.—Steam pressure-gauge on this principle, 18.—Modification of ditto for sea-going vessels, 18.—Barometers on this principle, 19.—Vacuum gauges on ditto, 19.—Thermometer on ditto, 19.—Pyrometer, for measuring high temperatures on ditto, 19.—Steam-engine indicator on ditto, 20.—Small experimental steam-engine, in which a bent and flattened steel tube is substituted for ordinary piston and cylinder, 21.—Rewards for these instruments at French Exposition of 1849, and Great Exhibition of 1851, 21.—Pressure-gauges ordered to be used by French Departmental Engineers, 21.

Discussion.—Belcher, Admiral Sir E., 22.—Brunel, I. K., 22.—Pole, W., 22.—Simpson, J., 22.

Mansel's pile-joint, xvi. 235.

MANSERGH, J. [Election, xviii. 406.]

MANSFIELD, C. B. [Telford premium, ix. 95.]

MANTELL.

Furnaces, admission of air to, xiv. 19.

Liquid hydrocarbons. "On the application of certain liquid hydrocarbons to artificial illumination; with a description of a new method of gas-lighting," viii. 207.—Remarks, 229.—Cost of crude benzole, and crystallization of different hydrocarbon vapours, 229.—Proportion of benzole obtained from different naphthas, 230.

MANTELL, Dr. G. A.

Geological strata. Structure of the chalk strata throughout the south-east of England, ix. 371.—Early condition of the rock, of the materials of which it is composed, and the changes it has undergone, 372.

Marine worms. The 'Teredo navalis,' ix. 56.

Water supply. Projects for supplying London with water, ix. 373.

Manufactories, advantages of constructing, on one floor, ii. (1842) 145.

Manufacture of locks by machinery, xiii. 271.

Manufactures. *Vide* MACHINERY.

Manure, ammonia and gypsum, ii. (1842) 68.

Manures, liquid, on the application of, by irrigation, xiii. 118.

Maplin Sand lighthouse, description of, (Redman, J. B.), ii. (1842) 150.

MARCHANT, R. M. [Election, viii. 273.]

MARCOARTU, Don A. da. [Election, xiii. 364.]

MARE, C. J. [Election, x. 57.]

MARGARY, P. J. [Election, vi. 134.]

MARILLIER, J. O. [Election, xviii. 406.]

MARINE BOILERS. *Vide* STEAM BOILERS, STEAM VESSELS, and STEAM NAVIGATION.

MARINE ENGINES.

'Alice.' "Description of the engines on board the iron steam tug, the 'Alice.'" By J. Patrick, i. (1840) 54.—Dimensions of the principal parts of the 'Alice,' 55.

Discussion.—Cursetjee, A., 68.

High-pressure steam in. "On the employment of high-pressure steam, working expansively, in marine engines." By J. Seaward, viii. 304.

MARTIN.

Discussion.—Crampton, T. R., 308.—

Faroy, J., 308.—Field, J., 308, 309.—

Fox, Sir C., 307.—Homersham, S. C.,

308.—Perkins, —, 309.—Rennie, G.,

307.—Russell, J. S., 305.

Main shafts of, causes of injury to, (Williams, C. W.), xiii. 468; (Braithwaite, F.), 468.

Vide also COMBINED VAPOUR ENGINE; STEAM BOILERS; STEAM ENGINES; and STEAM NAVIGATION.

Marine worms. Ravages of the 'teredo,' and 'terebrans,' vi. 54, 55.—Inquiry into the nature and ravages of the 'Teredo navalis,' and the means hitherto adopted for preventing its attacks (Paton, J.), ix. 23, *et seq.*—Natural history and habits of boring animals, 46 *et seq.*

— As to their attacking the creosoted timber of Leith pier, xviii. 437.

MARMONT, J. [Election, xiv. 491.]

Maroons, use of, as signals on railways, i. (1841) 116.

MARRABLE, F. [Election, xv. 281.]

MARSHALL, E. [Election, xvi. 188.]

MARSHALL, J.

Flax mill, advantages of the construction of his, ii. (1842) 144.

MARSHALL, J. G. [Election, i. (1838) 38.]

Smoke, prevention of, from engine-furnaces, xiii. 407.

MARSHALL, W. P. [Election, iv. 323.]

MARSHMAN, J. O.

Telegraph cables. Red Sea telegraph, and form of cable adopted, xx. 66.

MARTEN, E. B. [Election, xvi. 188.]

MARTEN, H. [Election, i. (1838) 24.]

MARTEN, H. J. [Election, xi. 422.]

MARTIN, —.

Locks and keys. As to lock-picking, xiii. 267.

MARTIN, A. [Election, viii. 273.]

MARTIN, Captain.

Steam navigation, &c. Fitting out 'Great Britain' for Liverpool and New York line, and also for Australian trade, xiv. 403.

MARTIN, H.

Timber. Decayed Kyanized sleepers at the West India docks, ii. (1842) 85.

MARTIN, S. D. [Election, viii. 164.]

MARTIN.

- Martin's improved Jacquard-machine, description of (Laforest, E.), xiii. 365.
- MARTINDALE, Captain B. H., R.E. [Election, xvi. 309.]
- MARTINEAU, W. [Election, xviii. 406.]
- Mashing-machines, power required to work, ii. (1843) 80.
- Masonry, general character of the, of the Royal Border bridge, over the river Tweed, on the York, Newcastle, and Berwick railway, x. 225, 236.—Force employed and work performed, 225.—Amount of work done by one crane in one day, 226.—Mode of putting masonry together, 233.—Mixing ashlar and rubble in the same work, 235, 238, 240.—Durability of rubble walls when built with good mortar, 236.—What is rubble, 238.—Weight which masonry will bear, 240.
- described as 'coursed walling,' specified for the sea-walls at Penmaen Mawr, x. 261.—Peculiar style of, called 'snecked rubble,' adopted for the Lockwood and other viaducts, 296, *et seq.*
- of two bridges over the river Don and the canal at Sprotbro', x. 304.
- *Vide also CONCRETE AND RUBBLE BÉTON.*
- MASSIE, J. L. [Election, i. (1838) 29.]
- MASTERS, Captain. [Telford premium, vii. 3.]
- Ships and steam vessels. "Account of the iron barque 'Josephine' of Liverpool, launched January, 1845," vi. 297.
- MATERIALS, STRENGTH OF.
- "On experiments on the strength of materials." By T. Webster, i. (1837) 27.
- Discussion.—Bramah, F., 29.—Cottam, E., 28.—Donkin, B., 29.—Hawkins, J. I., 28.—Hodgkinson, E., 29.
- Experiments by G. Rennie and others (Rennie, Sir J.), v. 34.—Deterioration of bodies subject to an intermediate strain (Fairbairn, W.), xiii. 468.
- MATHER, W. and C.
- Mather and Platt's earth-boring machine, xiii. 523; xiv. 523.
- Piston, elastic metallic, vii. 289.
- MATTHEWS, J. D. [Election, xvi. 188.]
- MATTHEWS, J. [Election, viii. 206.]

MAUGHAM.

- Ships and steam vessels. Difference in duty of the 'Garland,' post-office packet, the 'Basiliak,' man-of-war, and the 'Banshee,' x. 311.
- MATTHEWS, W. A. [Election, xiii. 421.]
- MAUDE, T. J. [Election, i. (1839) 54; premium, i. (1841) 10; resignation, xiii. 134.]
- Bridges. "An account of the repairs and alterations made in the structure of the Menai bridge, in consequence of the damage it received during the gale of January 7, 1839," i. (1841) 58.
- MAUDSLAY, H. [Election, viii. 164; Auditor, xviii. 163; xix. 181.]
- Arches. Experiments upon elliptical cast-iron arches, xviii. 359.
- Boilers, priming in, viii. 176.
- Canals, navigating vessels on, by means of screw propulsion, xiii. 211.
- Iron, wrought, forging of large masses of, xviii. 339.
- Locomotive engines, proportion of the length of stroke to the capacity of the cylinder in, viii. 260.
- Machines, riveting, particularly Fairbairn's and Garforth's, and as to his grandfather's machinery, for punching and shearing boiler-plates, for making iron water-tanks for the Royal Navy, xvii. 193.
- Metals. Mode of producing Stirling's metal, by mixing wrought and cast iron, xviii. 359.—Fracture of iron pipes under pressure, 401.
- Roofs of boiler factory and foundry at Messrs. Maudslay's manufactory, xiv. 267.
- Screw propellers, feathering, xiv. 398.
- Timber, creosoting, xviii. 438.
- Valves, vulcanized india-rubber for, xii. 456.
- MAUGHAM, —.
- Gold does not exist combined with sulphur, xv. 62.
- MAUGHAM, D.
- Gas, decomposition of coal, xvi. 322.
- MAUGHAM, W.
- Steam engines. Priming in the boilers of stationary engines, and means of preventing, viii. 182, 184.

MAULE.

Water, analyses of the, in a deep well at Holloway, and at Watford, viii. 181.

MAULE, G. B. [Election, ii. (1843) 155; memoir, x. 97.]

MAURY, Lieutenant.

Junction of the Atlantic and Pacific oceans. Table of the saving in time and distance from New York to different places, by the isthmus of Panamá, over the Cape routes (Kelley, F. M.), xv. 396.

MAXWELL, W. [Election, ii. (1843) 105.]

MAY, C. [Member of Council, vii. 56; viii. 44; ix. 91; x. 60; xi. 84; xii. 112; xiii. 123; xiv. 97; memoir, xx. 148.]

Abattoirs. Butchers' trade in London, viii. 77.—As to including offensive trades within the walls of an abattoir, 81.

Bells at the New Palace, Westminster, and atomic proportions of different alloys of copper and tin, xix. 13, 18.—Superiority of charcoal-smelted copper, 14.

Bridges. Reference to the comparative cost of boiler plate and lattice bridges, ix. 358.—Bridge on simple triangulation principle, for carrying the Great Northern railway across Newark dyke, xi. 12.

— "Account of a swing-bridge over the river Rother, at Bye, on the line of the Ashford and Hastings branch of the South Eastern railway," xi. 422.—Remarks, 426.—Advantages of system of three tie-bars adopted in ditto, 426.

Docks, entrance to the Ipswich, vii. 178.

Drainage of towns, vii. 100.—Ditto and utilization of sewage for agricultural purposes, xii. 83.—Rate of mortality at the Portland Convict Establishment, 84.—Quantity of pumping to be performed in the drainage of the district south of the Thames, xiii. 99.

Fire-arms, employment of machinery in manufacture of Colt's repeating, xi. 58.

Fire-proof buildings, especially in relation to the question of insurance, viii. 159.—Melting of cast-iron columns, and protecting them with a thin coating

MAY.

of brick, 159.—Effect of extensive fires upon iron columns, xii. 266.

Fuel, process of combustion of, xi. 402.—Means of getting rid of the sulphur from coke, xii. 378.

Furnaces, graduated admission of air to, xiv. 29.

Gas, leakage of, through mains, xvi. 319.—Deposition of carbon from the decomposition of gas, 322.

Governors. Application of Messrs. Siemens' chronometric governor to saw-mills, v. 265.

Horse-power, as to the term, x. 815.

Iron, properties of Scotch hot-blast, ii. (1843) 132.—Galvanising iron plates, xiv. 266.

Iron and steel. Defects in large forgings, xviii. 340.

Iron ore near Middlesbro'-on-Tees, xi. 28.

Locomotive engines, experiments with dilute sulphuric acid, for preventing priming in, supplied with water from the well at the Camden station, viii. 178, 184.—Importance of having an analysis of the gases in the smoke-box, xii. 426.

Machinery for the conversion of wood. Pendulum-saw for cross-cutting oak and elm timbers, and amount of work performed by it, xvii. 43.—Manufacture of the compressed trenails, 48.—Instance of the holding power of these trenails, 44.

Machines. Fineness of the fabric produced in the Jacquard-machine, xiii. 369.

Mines. Steam-jet at the Ebbw Vale colliery, and its use for blowing a cupola for smelting iron, x. 54.

Mortar, making, x. 233, 302.

Patent laws, from an inventor's point of view, x. 211.—Cost of patents, 212.

Permanent way. "On a new form of railway chairs and improved fastenings," i. (1841) 83.

— Rails, sleepers, and fastenings used on the Dublin and Drogheda railway, v. 239, 241.—Fowler's extended joint-chair, xi. 284.—Necessity of employing best materials for railway-

MAY.

- crossings and switches, xiv. 436.—Fish-plates used on the South-Western railway, compressed keys and trenails, the invention of the fish-joint, and Mr. W. H. Barlow's saddle-back rail, xvi. 279.—Bridge-rail, rolled from an ingot of cast steel, made under the 'Uchatius' system, 287.—Practical difficulty in rolling the contractors' form of rail, if of increased dimensions, 384.
- Railway, atmospheric, iv. 278, 285.
- Railway companies, impolicy of, becoming manufacturers, xi. 461, 464, 470.
- Railway system. Operation of the Encumbered Estates Court in Ireland, xviii. 43.
- Roofs, weight of, as compared with span, xiv. 271.—Cost of, 271.
- Steam. Indicator diagrams taken from an engine with a steam-jacket, xii. 597.—Use of superheated steam, xix. 476.
- Steam boilers. Difference in action of free muriatic acid and muriate of ammonia, and suggestions for preventing the incrustation of stationary engine-boilers, v. 214.
- Stone, porosity of artificial, made with a silica base, and of other building materials, vii. 69.
- Telegraph cables, mode of construction of, xvii. 301.
- Timber. Process of compressing trenails and wedges, ii. (1842) 74.—Kyanizing timber under exhaustion and pressure, 83.—Decayed Kyanizing tanks, 85.—Use of steam in compressing timber, 85.
- Water supply. Analysis of London water, viii. 185.—Depth of the chalk, and the supply of water from it at Colchester and at Harwich, xix. 48.—Depression of the water in the wells of London, 48.
- Working classes. Are American mechanics better educated than the same class in England? xi. 63.
- MAY, R. C. [Election, i. (1841) 116; resignation, xi. 93.]
- Railway curves. "On setting out curves for railways," i. (1841) 96.
- MAY, R. C. [Election, xx. 292.]

MENTAL CALCULATION.

- MEAD, C. J. [Election, xviii. 231.]
- Meadows' method of banding veneers, xvii. 36.
- MEARS, G.
- Bells at the New Palace, Westminster. Composition of the metal of the, xix. 15.
- MEASAM, T. [Election, xviii. 525.]
- Measures, weights, and coins, on the French system of, and its adaptation to general use (Yates, J.), xiii. 272.—*Vide* DECIMAL COINAGE, *ETC.*
- Measuring machine for determining minute differences of length, Whitworth's, x. 325.
- Meat, preservation of, ii. (1842) 82, *et seq.*
- Mechanical notation (Mr. Babbage's), explanation of some detailed diagrams of Scheutz' difference engine, illustrating, xv. 497.
- MEDHURST, G.
- Railway, atmospheric (Samuda, J.), iii. 259.
- MEDLEY, Major J. G., B.E. [Election, xx. 586.]
- MEISSONNIER, M.
- Engines. Report of, in reference to the performances of the ship 'France' belonging to the 'Compagnie de Navigation Mixte,' fitted with Du Trembley's combined-vapour engines (Jameson, J. W.), xviii. 237.—Extract from ditto, giving an account of the accident on board the ship 'France' in the port of Messina, 245.
- Melville's propeller, Wise's experiments with, xiv. 411.
- Memoirs of deceased members, i. (1837) 5; (1838) 9; (1839) 12; (1840) 12; (1841) 13; ii. (1842) 12; (1843) 11; iii. 10; iv. 6; v. 4; vi. 5; vii. 7; viii. 10; ix. 98; x. 72; xi. 93; xii. 126; xiii. 138; xiv. 120; xv. 90; xvi. 102; xvii. 92; xviii. 186; xix. 168; xx. 134.
- MENTAL CALCULATION.
- "On mental calculation." By G. P. Bidder, xv. 251.—Can be taught as easily as ordinary arithmetic, 252.—Requires no extraordinary power of memory, 253.—Registering powers of the mind limit the extent to which it

MENTAL CALCULATION.

may be carried, 254.—Powers of registration limit the power of calculation, 255.—Should be restricted to multiplying three figures by three figures, 256, 263.—How Mr. Bidder obtained peculiar power of dealing with numbers, 256.—Chronological experience of Mr. G. P. Bidder as a mental computator, 257.—Number of facts to be registered by this process, in multiplying three figures by three figures, less than what is requisite for the acquisition of the common multiplication table up to 12 times 12, 259.—Essential difference in the mode of manipulation, adopted by the mind, and when recording it on paper, 259.—Examples in multiplication, 260.—Process adopted, one of natural algebra, 261.—Mental calculation depends on two faculties of the mind, in simultaneous operation, computing and registering the result, 262.—Importance of beginning to study numbers and quantities naturally, before being introduced to them through the medium of symbols, 262.—Multiplication table the key to all other processes in arithmetic, 263.—Addition and subtraction performed mentally, 264.—Division more difficult than multiplication; facility afforded by mental calculation is, the greater power of guessing at every step towards the result, 264.—Multiplying pounds, shillings, and pence by any number, with example, 265.—Useful to bear in mind the number of seconds in a year, inches or barleycorns in a mile, ounces or pounds in a cwt. or ton, pence or farthings in a pound sterling, &c., 265.—Example to find the number of seconds in 87 years, 265.—Ditto of barleycorns in 587 miles, 266.—Rules and expedients adopted for extracting the roots of perfect squares and cubes, 266.—Compound interest calculated by means of the summation of series, with example, 267.—Ditto of any sum of money expressed algebraically, 271.—Prime numbers; processes for ascertaining the factors of a number, and

METALS.

thereby determining whether it is a prime or not, 272.—Mode by which the faculty of mental calculation can be applied to engineering, 274.—Example, when Mr. Bidder was engaged for the Canal interest in opposing the original Manchester and Liverpool railway, 275.—Ditto in ascertaining how long the floodwaters would be retained on the land, when giving evidence on the Northampton and Peterborough railway bill, 275.—Ditto in determining flow of water, 276.—Mode of ascertaining the velocity of flight of a cannon-ball, as determined during some experiments in gunnery by Mr. Whitworth, 277.—Mode by which mental arithmetic should be taught, 277.

Discussion.—Stephenson, R., 280.

MEREDITH, G. [Election, viii. 164.]

MEREDITH, J. B. [Election, xviii. 406.]

MESSENT, P. J. [Election, xx. 258.]

Metallic salts, used for preserving timber, ii. (1842) 87.

—sheathing for ships, ii. (1842) 165, 168.

METALS.

Corrosion of, i. (1839) 33, 34, 37.—Patents for preventing the corrosion of copper (Wilkinson, J. J.), ii. (1842) 67.

—Corrosion of iron sheathing in ancient vessels, 168.—Of iron cylinders in pits, by the combined action of the mine water and smoke (Atkinson, R. T.), 171.

—“On the action of air and water, whether fresh or salt, clean or foul, and at various temperatures, upon cast and wrought iron and steel.” By R. Mallet, ii. (1843) 171.—Periods of exposure of, during experiments, 171.—Temperature of water in which the specimens were immersed, 171.—Mode of analysis, 172, 173.—Causes of the corrodibility, 173.—Progression of corrosion, with regard to time, 174.—Influence of oxide and plumbago on corrosion, 174.—Corrosion accelerated by foul sea-water evolving sulphuretted hydrogen, and by soft putrefying mud,

METALS.

- 175.—Origin of the formation of plumbago on iron exposed to the action of water, 175.—Constituents of oxides of iron, 175.—Destroyed by the contact of Kyanized timber, 177.
- Discussion.—Braithwaite, F., 180.—Field, J., 178, 179.—Jordan, —, 179.—Manby, C., 180.—Rendel, J. M., 178.—Ure, Dr., 178, 179.—Vignoles, C., 179.—Walker, J., 179, 180.—Williams, C. W., 178, 179.
- Corrosion of. "On the corrosion of metals." By R. Adie, iv. 323.—Experiments as to means of preserving them from the joint action of air and water, 323.—On the oxygen dissolved by water, 325.—Table of ditto, 326.—On the rate of action of brine, sea and fresh water, in corroding, 327.—On some experiments on the action of water in developing electricity, 329.
- Discussion.—Farey, J., 331.—Lowe, G., 332.—Rennie, Sir J., 333.
- Corrosion of. Injurious effect of gas upon gun metal communication joints (Vulliamy, B. L.), v. 362.—Compositions for preventing the corrosion of iron plates of vessels (Masters, Capt.), vi. 307.
- Fatigue and fracture of. "On the fatigue and consequent fracture of metals." By F. Braithwaite, xiii. 463.—Accident to cast-iron girders at a London brewery, 464.—Defective joints of a refrigerator, composed of a series of oval copper pipes, 464.—Defective wrought-iron back-plate of a locomotive boiler, 465.—Accidents to the cast-iron cranks of some three-throw pumps, 465.—Possible railway accident, by the detachment of the ash-pan of the locomotive, when the train is at full speed, 466.
- Discussion.—Braithwaite, F., 467, 468, 472.—Clark, D. K., 469.—Crampton, T. B., 469.—Dines, T., 471, 472.—Errington, J. E., 474.—Fairbairn, W., 468, 469, 470.—Grissell, H., 471.—Hawkshaw, J., 469, 474.—Hawksley, T., 473.—Humphrys, E., 470.—Phipps,

METALS.

- G. H., 472.—Rankine, W. J. M., 467.—Sewell, J., 471.—Simpson, J., 475.—Vignoles, C., 470.—Williams, C. W., 468.
- Fusion of. "On the autogenous uniting of lead and other metals." By M. Delbriick, i. (1840) 27.
- Galvanic action of the oxide of, (Brande, Prof.) ii. (1842) 153.
- Gun metal, composition of, (Jordan, J. B.), iii. 88; (Braithwaite, F.), 88.—Substitution of gun-metal gratings for cast-iron ones, at Messrs. Hanbury's brewery (Davison, R.), vii. 158.
- Punching holes in. "An account of some experiments to determine the force necessary to punch holes through plates of wrought iron and copper." By J. Colthurst, i. (1841) 60.
- Discussion.—Sopwith, T., 61.
- South-Eastern Africa, specimens of coal, iron, copper, galena, &c., discovered in, (Sowerby, W.), xvi. 84.
- Tin and copper ores. "On the methods generally adopted in Cornwall, in dressing tin and copper ores." By J. Henderson, xvii. 195.—Tin-dressing, 196.—Ragging, spalling, and vanning, 196.—The stamps, 197.—The grates, 198.—The strips, 198.—Buddling, 199.—Tossing, 200.—Packing, 200.—Circular buddles, 201.—The separator, 202.—Wilkins' separator, 203.—Trunking machine, 203.—The frame, 203.—The hand-frame, 205.—Hand-trunking, 205.—The burning-house, or oven, 206.—The calciner, 206.—The tyes, 207.—Chimming, 207.—Dilluing, 208.—Dressing copper ore, 208.—The slides, 208.—Ragging and spalling, 208.—Revolving griddle, 208.—Bucking, 208.—The crusher, 209.—Cobbing, 209.—Picking, 209.—Jigging, 210.—Petterick's separator, 210.—Results of experiments as to work performed by the separator, compared with the operation of jigging, 211.
- Discussion.—Edwards, S., 213.—Hunt, R., 213.—Locke, J., 220.—Mackworth, H., 218.—Smyth, W., 216.—Taylor, J., 214, 219.

METEOROLOGY.

Vide also BELLS; IRON; and IRON AND STEEL.

Meteorology, v. 115.

METERS.—*Vide* GAS METERS, and WATER METERS.

METFORD, W. E. [Election, xv. 281.]

Theodolite combining several improved arrangements, xv. 247.

Metrology; on the French system of measures, weights and coins, and its adaptation to general use (Yates, J.), xiii. 272. *Vide* DECIMAL COINAGE, &c.

Metropolis, defence of the, xx. 415, *et seq.*

MICA.

"On the use of mica, as a substitute for glass, in the windows of workshops."

By J. Glynn, i. (1840) 43.

Used for the chimneys of lamps, ii. (1842) 189.

Middlebro'-on-Tees, town and port of, (Turnbull, G.), v. 248.

MILES, P.

Fire-arms, repeating, xi. 58.

Mill, corn, constructed of iron, for Turkey, ii. (1842) 126.

—, flax, description of, (Combe, J.), ii. (1842) 142.

MILLAR, W. [Election, i. (1841) 168.]

MILLER, G. M. [Election, iii. 342.]

MILLER, J. [Member of Council, i. (1840) 36; ii. (1843) 67; iii. 66; iv. 62; v. 142; vi. 46; vii. 56; viii. 44; ix. 91; x. 60; xi. 84; bequest, xx. 180; memoir, 149.]

Engines, friction of, ii. (1843) 71.

Iron, changes produced by hammering, and fracture whilst in the hands of the smiths, ii. (1842) 182.

Ships and steam vessels. Strength of iron vessels, as instanced at the launch of the 'Prince of Wales,' iv. 305.—Lithographic drawing of ditto, 306.

Steam navigation, &c. Relative advantages of the screw-propeller and paddle-wheels under certain circumstances, iv. 167.

MILLER, J. F. [Election, x. 192; memoir, xvi. 166.]

Rainfall. Extracts from his Report, as to the gradation in the quantity of rain, at different elevations above the sea,

MILWARD.

and the unequal distribution of rain in the climate of Great Britain (Bateman, J. F.), vii. 277.

MILLER, W.

Automaton balance. Comparison between weighing sovereigns by hand and by the automaton balance, ii. (1843) 123.—Weighing by hand, 125.

Decimal coinage, &c. Desirability of establishing decimal gradations in weights, measures, and moneys, xiii. 330.—Tenpence and a franc not identical, 331.—Not a single element common to the French and English systems of weights and measures, 332.—Advantages supposed to have been gained by making the pound avoirdupois equal to 7,000 grains, 332.—Troy and Tower pounds, 332.—Present multiples of the pound weight ought to be abolished, 333.—Pound sterling, as the unit of account, in a decimal currency, 335.—Assumed difficulties in regard to the postage-stamps and labels, 335.

MILLINGTON, J., and ANDRÉS DEL RIO.

Gold. Extract from their report as to gold districts of Virginia, U.S. (Hopkins, E.), xv. 69.

MILLS, G. [Election, i. (1840) 33.]

Steam vessels. Proportion of the power of the engines to the tonnage in steam-vessels, i. (1841) 69, 70.

Naval construction, &c. Compressed trenails for ship-building, i. (1841) 86, 87.

MILLS, G. [Election, ii. (1843) 134; memoir, xix. 191.]

Bridges, suspension, failure of the Yarmouth, iv. 296.—Hungerford, 296.

MILNE, J.

Gas. "Description of a new gas-regulator," i. (1840) 61.

Machines. "Description of the piling machine used at the Montrose harbour works," (Page, G. T.), iii. 197.—Remarks, 290.

MILNER, J. [Election, i. (1838) 46.]

Milton iron-works, experiments upon the strength of cast and malleable iron at, (Musket, D.), ii. (1843) 126.

MILWARD, A.

MINERALOGY.

Decimal coinage, &c. Propriety of keeping the consideration of coinage distinct from weights and measures, in discussing plans for the decimalization of measures, weights and coins, xiii. 340.—Best decimal system of coinage for this country, 340.—Is it advantageous to strive for one uniform monetary system throughout the world? 340.—Advantages of the pound and mill scheme for a decimal system of coinage, 343.

Mineralogy, on the study of, as a part of engineering, v. 107.

Miner's lamp, Biram's, viii. 139.

Mine ventilator, Struvé's, viii. 129.

—, W. Brunton's, x. 55.

MINES.

Apparatus for miners. "Description of a machine for raising and lowering miners." By J. Taylor, ii. (1843) 193.—Premiums offered for, in Cornwall, 193.—Prizes awarded to Messrs. Loam, Nicholas, Richards, and Phillips, 193.—Similar machines at work in the Hartz mines, 193.—First machine erected at the Treavean copper-mine, 193.—Speed of raising the men, 194.

Discussion.—Buddle, J., 194, 195.—Taylor, J., 194.

Clay in, expansion of, (Hawkshaw, J.), iii. 152.

Drainage of, by water wheels (Taylor, J.), ii. (1842) 97.—Alte Mordgrube, silver, by water-pressure engine (Baker, W. L.), ii. (1843) 143.

Lighting. "On lighting mines by gas." By A. Wright, xvii. 1.—Progress and extension of gas-lighting, 1.—Use of coal-gas for other purposes, 1.—Expenses incurred in lighting mines by the antiquated oil-lamp and tallow-candle, 1.—Reasons for selecting a Cornish mine, in which to try the system of lighting by gas, 2.—Description of the Ballewidden mine, 2.—Usual mode of lighting, 3.—Plan adopted for causing the gas to descend the mine, and description of the fittings employed, 3.—Comparative expense of the two systems of lighting,

MINES.

4.—Relative quantities of light per annum, 4.—Products of combustion under the two systems, as bearing on the sanitary condition of the mine, 4.—Estimate of the amount of carbonic acid produced per day, from respiration, the burning of candles, and the explosion of gunpowder, 5.—Ditto where gas is used, 6.—Advantages anticipated from the employment of gas for the lighting of mines, 6.—Measures taken to guard against an explosion of gas, 6.

Discussion.—Burnell, G. R., 9.—Hartnum, —, 11.—Hawksley, T., 13.—Longridge, J. A., 11.—Perkins, E. M., 12.—Winsor, F. A., 12.—Wright, A., 8, 14.

Sinking, &c. "On the sinking and tubbing, or coffering of pits, as practised in the coal districts of the North of England." By R. T. Atkinson, ii. (1842) 170.—Early methods of draining, 170.—Quantity of coal raised per day, 171.—Quantity of water pumped per day, 171.

Temperature of, ii. (1843) 141, *et seq.*

Ventilation of. "On the ventilation of mines." By J. Richardson, vi. 160.—Gases evolved from the strata, on working coal, iron, &c., 161.—Ordinary means of ventilating collieries, by two shafts, 163.—Explosion in the Felling colliery, Newcastle, on the 25th of May, 1812, 165.—The Society for Preventing Accidents in Coal mines, 165.—Dr. Clanny's safety-lamp, 166.—The 'Geordie' lamp, 166.—The Davy lamp, 166.—Object achieved by the discovery of the safety-lamp, 167.—Explosion at Haswell colliery, Durham, on the 28th of September, 1844, and the causes, 168.—Defects of the present system, and means suggested for removing them, 170.—Mr. W. P. Struvé's mine ventilator, 171.—Report of a Committee appointed to investigate the causes of the explosions in the year 1839, at South Shields, 172.—Extracts from the reports of the 'Children's Employment Commission,' 173.—Necessity for the

MINES.

efficient ventilation of mines, 175.—Appendix, section of the Newcastle coal measures, 176.—Ditto, the depth and thickness of the seams of coal, in the Newcastle coal-field, 178.—Ditto, the depths of various collieries in the Newcastle district, 179.—Ditto, section of the strata in the B pit of the Hebburn colliery, Newcastle, 179.—Ditto, section of minerals at Mynydd Caerau, near Maesteg, South Wales, 180.—Ditto of the strata sunk through to the Milford vein of anthracite coal, at the Gwaun-cae-Gurwen colliery, Llanquicke, Swansea, 181.—Explanation of the plates, 182.

Discussion.—Braithwaite, F., 204.—Buckland, Dr., 194, 203, 205.—De la Beche, Sir H., 196, 204.—Dunn, M., 183.—Forster, F., 205, 210, 212.—Hawkins, J. L., 190.—Hawksley, T., 191.—Horne, J., 192, 196.—Locke, J., 191.—Murray, J., 207, 212.—Pasley, Lieut.-Gen. Sir C. W., 190.—Parkins, —, 189.—Stephenson, R., 186, 196, 205, 210.—Taylor, J., 184, 190.—Taylor, J., Jun., 188.—Wood, N., 193, 196, 203, 204, 205.

Ventilation of. "The ventilation of collieries, theoretically and practically considered." By W. P. Struvé, x. 22.—General rules, 22.—Limitation to the velocity of the currents of air, 22.—Manner of laying open a coal field, 23.—Amount of ventilation required in mines evolving fire-damp, 23.—Ventilation of compartments, or subordinate collieries of the mine separately, 24.—Demonstration that the splitting system insures the greatest efficiency, 24.—Circumstances affecting the velocity of the current of air in a mine, 26.—Ventilation at the Eaglesbush colliery, and experiment as to quantity of intake compared with the return air, 27.—Ditto at the Cwm Avon Iron and Coal Works at Taiabach, 28.—Ditto at the Ynisdavid colliery, 29.—Motive powers in general use for accelerating the air currents of mines, 30.—Extracts from the Minutes of Evidence, taken in 1849,

MINES.

before a Committee of the House of Lords, as to the ventilation of the Haswell, Hetton, and Seaton Delaval collieries, 30.—Formula for determining the elongation of any column of air in an up-cast pit, 33.—Ditto as applied to Haswell, Hetton, Cwm Avon, and Eaglesbush collieries, 33.—Calculations tending to illustrate the necessity of deep shafts, 35.—The steam jet as a ventilator for mines, 35.—Experiments as to ditto, by Mr. N. Wood, Mr. G. Elliot, and Mr. H. H. Vivian, 36.—Mine ventilator at the Eaglesbush colliery, Neath, 38.—Objections to mechanical ventilation considered, 39.—Mr. J. Phillips' opinion as to the injury which the furnace causes in the upcast shaft, 39.—Mr. J. K. Blackwell's remarks as to special cases of departure from correct principles in Lancashire, South Wales, &c., 40.—Ditto on the subject of ventilation generally, 41.—Velocities attainable by, and description of, the mine ventilator, 43.

Discussion.—Ansted, Prof., 52.—Arnott, Dr., 46, 54.—Darlington, J., 49.—Forster, F., 45, 52, 53.—Gordon, A., 53.—Gurney, G., 51, 53, 54.—Hann, J., 52.—Hopkins, E., 48.—Manby, O., 51, 55.—May, C., 54.—Struvé, W. P., 55.

Ventilation of. "On the pneumatics of mines." By J. Richardson, xii. 272.—Difference in the quantity of air supplied to mines in different districts, 272.—Chemical constitution and properties of atmospheric air, 275.—Its uses in the animal economy, 278.—Ditto for diluting and rendering harmless dangerous gases, 279.—Opinion of Dr. J. Murray, of Hull, as to the importance of the Eudiometer, for testing the state of the atmosphere in mines, 281.—Choke-damp, 282.—Indications of presence of ditto, 283.—Fire-damp, 283.—Analysis of ditto by Sir H. Davy and Prof. Graham, 285.—Chemical diagram by the late Dr. Clanny explanatory of the phenomena of an explosion of fire-damp, 285.—After-damp, 286.—Gases usually found in a great measure stra-

MINING MACHINERY.

tified, 287.—After-damp more destructive to animal life than the fire and 'blast' of an explosion, 288.—Inquiry as to the quantity of air required to pass through a mine in a given period, 288.—Table showing the air required in a mine of 50-feet mean area, employing from 30 to 100 men, and the air coursing different distances, 290.—Ditto for different areas, 291.—Rules for giving the quantity of air required, 293.—Statement of the amount of ventilation in different collieries, 294.—Allegation that fire-damp is produced in such abundance in some collieries, that it is impossible to dilute it, inconsistent with recorded facts and opinions, 295.

Discussion.—Gibbs, J., 306, 310.—Gordon, A., 297, 309.—Mackworth, H., 297, 308, 309.—Simpson, J., 311.—Stephenson, R., 306, 308, 309.

Vide also COAL MINES, and METALS.

Mining machinery, and pump valves, iii. 88, *et seq.*

Mining operations in Great Britain, v. 108.

MIRRORS.

"A mode of bending discs of silvered plate glass into concave or convex mirrors by means of the pressure of the atmosphere." By J. Nasmyth, i. (1840) 31.

Discussion.—Lowe, G., 32.—Macneill, Sir J., 33.

Miser, used in sinking wells, ii. (1842) 64, 192; (1843) 59.

MITCHELL, —, Jun.

Wells. "Description and drawing of an apparatus designed by Mr. Mitchell for boring wells," i. (1837) 18.

MITCHELL, A. [Telford medal, viii. 5; resignation, xvii. 85.]

Foundations under water. "On submarine foundations, particularly the screw-pile and moorings," vii. 108.—Remarks, 135.—System of screw-moorings in the Tyne, 135.—Screw-pile pier at Courtown, 142.—Depth of penetration of screw-piles, 144.—Terms for the right of using the screw piles and moorings, 145.

MOODY.

Lighthouses, construction of, relative expense of iron and stone, and comparative merits of floating and fixed lights, vii. 140.

MITCHELL, A. [Election, iv. 372; memoir, ix. 103.]

MITCHELL, T. T. [Election, iv. 372.]

MITCHELL, W. [Election, iv. 186; memoir, ix. 104.]

Railway, American trellis, vi. 79.

Mitchell and Lawton's tumbler lock, with series of detectors, patented in 1815, xiii. 257.—Revolving curtain for closing the keyhole, 267.

Mitchell's screw piles, and moorings (Redman, J. B.), ii. (1842) 150; vii. 146; (Mitchell, A.), 108.

—, use of, for lighthouses, and for the foundations of other works, x. 319.—Use of, for proposed circular wrought-iron, sea-light tower, xv. 13.

Mitchell's spiral-screw water-meter, xvi. 59, 62.

MODEL MAPPING.

"On the construction of model maps, as a better mode than sectioplanography for delineating the drainage and agricultural improvements of a country, or projected lines of railways, canals, &c." By J. B. Denton, ii. (1842) 155.

Modelling, v. 114, 178.

Mole at Venice, vi. 128.

MOLESWORTH, G. L. [Election, xiii. 364; Telford medal and Manby premium, xviii. 174.]

Labour, skilled, in Portugal, xviii. 18.

Machinery. "On the conversion of wood by machinery," xvii. 17.—Remarks, 49.—Points which require attention in the construction of such machines, 49.

MONT RICHER, M.

Bridge-aqueduct on the line of the canal of Marseilles, xiv. 223.—Details of cost, and quantity of materials employed, 230.

MOODY, Lieutenant R. C., R.E. [Election, i. (1839) 54.]

MOODY, S. B. [Election, ii. (1843) 105.]

Water-wheels. "Description of a water-wheel constructed by Mr. W. Fairbairn,

MOORE.

- M. Inst. C.E., and erected in Lombardy," iii. 66.
- MOORE, G. [Election, i. (1839) 42; resignation, xi. 93.]
- MOORE, W. W. [Election, xx. 258.]
- Mooring buoys, beacons, sea-lights, &c. (Herbert G.), xv. 1.
- Mooring, screw-pile and, on submarine foundations, particularly the, (Mitchell, A.), vii. 108.
- MOORSOM, Admiral.
- Steam vessels. Pamphlet by him, entitled 'Considerations on steam vessels,' (McConnell, J. E.), xvi. 848.
- MOORSOM, Captain W. S., [Telford medal, iv. 8.]
- Arches of Royal Border bridge, over the Tweed, span of, x. 234, 238.
- Artillery. Size of the bore in rifled small arms, and construction of artillery, xix. 400.
- Beams. Comparison between Warren and lattice, xii. 610.—Professor Barlow's rule for calculating the strength of, xiv. 487.—Warren, trellis, and plate-beams, 487.—Facility of construction of trellis, as compared with tubular plate-beams, 489.
- Bridges, trussed iron, iii. 60.
- "Description of a cast-iron bridge, completed in the year 1840, for carrying the Birmingham and Gloucester railway over the river Avon, near Tewkesbury," iii. 60.—Remarks, 62.
- Wrought-iron lattice, on Dublin and Drogheda railway, iii. 64.—Athlone, viii. 303.—Vertical lift, over the Grand Surrey canal, on the line of the Thames junction branch railway, ix. 309.—Bridge proposed to be erected over the Rhine, at Cologne, xiv. 487.
- Buoys, beacons, sea-lights, &c., and manner of mooring them, xv. 14.
- Defences, national, of the United Kingdom, xx. 452.—Number of war vessels and of seamen, available for immediate service, possessed by Great Britain, France, and Russia, and the extent of coasts, with a population accustomed to sea-going habits, in

MOORSOM.

- each case, 452.—Navy should be the pivot point, or groundwork of the national system of defence, 453.—Instances in history, of arsenals unsuccessfully held by an invading enemy, although strongly fortified, 453.—Arsenals on the sea-board should in future only supply the necessities of a port, 454.—What civil engineers have done, and may do, for the advancement of the practical defences of the nation, 454.—Shot-proof boat for the defence of harbours, 455.—Land defences, 456.—General system of national defence, 457.
- Drainage of the district south of the Thames, xiii. 98.—Plan proposed by him, in 1849, for the drainage of the metropolis, xv. 244.
- Execution of works. Duties which devolve upon an engineer in the management of works in distant regions, especially in tropical countries, xix. 255.
- Ferries. Detentions in crossing the Nile ferry, xvii. 64.
- Fire-proof buildings. Intensity of heat in fires, viii. 156.
- Foundations of the new bridge at Rochester, method of forming, x. 367.
- Horse power, x. 818.
- Junction of the Atlantic and Pacific oceans, across the Isthmus of Panamá, from near Cupica Bay to the Napipi, ix. 86.
- Locomotive boilers, xii. 425.—Experiments on South Devon and Exeter railways, 426.
- Locomotive engines. "Account of a series of experiments on locomotive engines, more particularly on the 'England,' the 'Columbia,' and the 'Atlantic,' manufactured by Mr. Norris, of Philadelphia," i. (1840) 45.—Remarks, 47.—Intended use of American locomotives on the Birmingham and Gloucester railway, 47.
- , American, ii. (1843) 100.—Priming in locomotive engines, and remedies for its prevention, viii. 179.—'Wien-Raab' locomotive engine, xv. 46.—Locomotive engines for ascending in-

MOORSOM.

- clines and going round curves, 46.—Proportion of the weight available as tractive force, and performances on steep gradients on the West Cornwall and South Devon railways, and on the Lickey incline, xviii. 67.
- Marine worms. Operations of the 'Teredo navalis,' vi. 54.
- Mortar, cause of difficulties in making, x. 234.
- Permanent way. Hollow wrought-iron keys, iv. 57.—Dublin and Drogheda railway, v. 241.—Advantages of longitudinal sleepers, viii. 269.—Waterford and Kilkenny railway, ix. 408; xi. 281.—Effects of expansion and contraction on railway bars, xi. 280.—First cost and maintenance of different systems, 281.—Permanent way, particularly in tropical countries, xviii. 439.
- Pipes, leakage through metal, iv. 219.
- Railway cuttings and drainage, iii. 157.
- Railway inlines, expense of working ii. (1843) 101, 108.
- "Statement of observations made during the running of the ordinary trains, on the incline planes of the Waterford and Kilkenny railway, between the months of August, 1848, and January, 1849," viii. 287.—Remarks, 296.
- Mode of working, on the West Cornwall, in 1849, x. 251.—Power of the breaks on incline planes, 251.—All incline planes induce inconvenience, 251.—Incline plane at Liège, 254.—Results of working the Semmering, Giori, Lickey, and Dainton inclines, xv. 365, 368, 374.
- Railway stations, on laying out a goods station, viii. 177.—Cost of moving and distributing goods, at five stations, on a railway in Cornwall, 179.
- Railway trains, resistances to, and experiments on incline planes, vii. 817.
- Railways. Legislative interference in the construction of, ix. 244.—'Zig-zag' method of constructing, for crossing high mountains, xviii. 69.—Importance of thorough drainage of, in tropical countries, 440.

MORELAND.

- Rivers. Use of permanent groynes may be very prejudicial to the ultimate condition of a river, xii. 20.
- Roofs, iron, at Kilkenny, xiv. 272.
- Screw-piles and moorings. Economy resulting from the employment of screw-piles, and their use hitherto limited by an excessive royalty, vii. 42.
- Sea defences. Groynes on the South Rocks, Sunderland, viii. 198.—Ditto South Devon coast, and near Brighton, and angle which groynes should make with the shore, 201.
- Sea-walls, construction and outline of, x. 275, 276.—Ruins of the castle of Henry VII., in the Bay of Sandwich, Kent, 275.
- Tides of the North Sea, xx. 856.
- Timber. Kyan and Margary's processes for preserving, xii. 231.—Experiments as to transverse strength of, prepared by Kyan's process, 231.—Timber available for railway purposes in Ceylon, xviii. 439.
- Viaducts. "Description of the viaduct erected over the river Nore, near Thomastown, in the county of Kilkenny, to carry the Waterford and Kilkenny railway," xi. 426.
- MOORSOM, G.**
- Ships and steam vessels. Mode of internal measurement proposed for ascertaining tonnage (Henderson, A.), xiii. 18.
- MORANT, A. W.** [Election, xiii. 241.]
- MORAWSKI, A.** [Election, i. (1841) 158.]
- MORREAU, M.**
- Engines. Report of experiments to determine the relative economy of Du Trembley's combined-vapour engines, and of similar engines arranged to work by steam alone, using a diminished quantity of steam, a greater expansion, and surface condensation (Jameson, J. W.), xviii. 238.
- MORELAND, R.**
- Asphalte, use of, at the Giltspur-street Compter, ii. (1843) 97.
- Metals. Crystallized texture exhibited by pump-rods, &c., broken suddenly

MORIN.

from continued percussion, ii. (1842) 181.

MORIN, M.

Friction, experiments upon (Pole, W.), ii. (1843) 75.—Influence of unguents on the laws of friction, 77.

Indicators. Spring for compteur, or indicator (Moseley, Professor), ii. (1842) 103.—Compteur employed for measuring the traction of horses, 106.

Water-wheels, results of experiments on, (Rennie, G.), ii. (1843) 64.

MORISON, J.

Decimal coinage, &c. Mode of making a change from the present plan to a, and integers to be retained, or created, xiii. 316.

MORLAND, Sir S.

Arithmetical instruments. Present of his scarce work on "Arithmetick Instruments," 1673 (Farey, J.), iii. 70.

Pumps. Plunger for force pumps used by him at Marly in 1683 (Taylor, J.), iii. 91.

MORNAY, A. A. DE. [Election, ii. (1842) 56.]

MORRISON, R. [Election, xx. 586.]

MORTAR.

Hydraulic. "An investigation into the theory and practice of hydraulic mortar, as made on the new works of the London Dock Company, 1856-57." By G. Robertson, xvii. 410.—Misconception of the word 'hydraulic,' 410.—Observations on carbonate of lime, the origin of mortar, 411.—Calcination and slaking of blue lias lime, 411.—Action of silica in protecting it from solubility, 413.—Slaking by spontaneous extinction, 416.—Methods of slaking by immersion, and by throwing water over it, compared, 416.—Proportion of sand and lime in mortar, 417.—The first hardening, or 'setting' of mortar, 417.—Table of the force required, in lbs. to tear asunder pairs of grey stock-bricks, cemented together with four different materials, 419.—Injurious effect of quick setting, 420.—Induration that takes place by the lapse of time, 421.—Absorption of carbonic

MOSELEY.

acid by the mortar, 421.—Experiments with some of the other ingredients deemed useful in hydraulic mortar, as alumina, manganese, iron and its oxides, iron filings, forge scales, minion, slags, ashes, and magnesia, 423.—Account of the methods employed, and the cost of manufacturing mortar at the London docks, 426.—Effect of grinding, on the strength and density of lias mortar, 430.—Appendix—London dock extension; estimate of the cost of hydraulic mortar prepared by the Company, 432.

Discussion.—Hawkshaw, J., 439.—Pearshall, T. J., 438.—Robertson, G., 435, 440.—White, G. F., 435.

Proportions of the materials in the mortar used on the Amsterdam railway (Conrad, Chev.), iii. 177.—Ditto, and method of preparing the mortar and grout used in building the Royal Border bridge over the Tweed, at Berwick (Bruce, G. B.), x. 226, 228, *et seq.*—Mortar used at King's Cross station of the Great Northern railway (Radford, W.), 234.—Ditto in the construction of the Lockwood viaduct (Hawkshaw, J.), 297.—Character of sand and lime which should be used, 301, *et seq.*—Mortar used on works of Birmingham extension of Birmingham and Oxford Junction railway; composition, weights when wet and dry, test of qualities (Lane, C. B.), xi. 71.—Ditto for the construction of the Sunderland docks (Murray, J.), xv. 423.

Vide also CEMENTS; and CONCRETE AND RUBBLE BÉTON.

Mortars, the two wrought-iron, each 36 inches diameter, and the Mersey Company's wrought-iron gun, 13 inches calibre, manufacture of, xviii. 301, *et seq.* Mortising machines and chisels, xvii. 34.

MORTON, F. [Election, xiv. 491.]

MOSELEY, Professor.

Friction, ii. (1843) 75.

Indicators. "Results of a trial of the constant indicator, upon the Cornish engine at the East London water-works," ii. (1842) 102.

MOSS.

Moss, —.

Timber, test for ascertaining the degree of saturation of, in the process of Kyanizing, ii. (1842) 84.

Motion of shingle, sand, &c. Observations on the causes tending to alter the outline of the English coast, to affect the entrances of the rivers and harbours, and to form shoals and deeps in the bed of the sea (Harrison, J. T.), vii. 327. *Vide also* CHESIL BANK, and COASTS.

MOUGEL BAY.

Foundations, machine for excavating, at the barrage of the Nile (Stephenson, R.), x. 368.

Moulding-machines, xvii. 30.

MOULTON, S. [Election, xvi. 188.]

Mount's bay pier, ii. (1842) 129.

MOXHAM, E. [Election, x. 192.]

MUIR, G.

Smoke. Place for the admission of air into engine-furnaces, to prevent the emission of smoke, xiii. 408.—Mechanical means for the prevention of smoke, 408.

MUIR, J.

Gas, penetration of, into water pipes, iii. 308.

MUNDAY, G. J. [Election, ix. 303; Council premium, xv. 81, 104.]

Coffer-dams. "Description of the coffer-dams, used in laying the lines of water-pipes between Twickenham and Richmond, crossing the river Thames," xiv. 32.—Remarks, 37.

MUNDAY, J. [Election, i. (1841) 101; resignation, x. 72.]

Muntz metal, composition of, ii. (1842) 69.

MURPHY, J. [Election, vi. 134.]

MURPHY, J.

Bells of the New Palace, Westminster. Composition of the metal, the casting, and the shape of, xix. 19.—Bell selected to strike the hours at the Great Exhibition, 19.

MURRAY, A. [Election, i. (1838) 24; Telford medal, iv. 8; Member of Council, 62.]

Engines. Du Trembley's combined-vapour engine, xviii. 271.

MURRAY.

Metals, porosity of, iii. 304.

Steam boilers. "On the construction and proper proportions of boilers for the generation of steam," iii. 331.

— horizontal and vertical tubular, xi. 397.—Combustion of fuel, and absorption of caloric, 399, 403.

MURRAY, E. F. [Election, xix. 489.]

MURRAY, J. [Telford medal, iv. 8; vii. 3; Telford medal and Council premium, xvi. 92; Member of Council, xix. 132; xx. 108.]

Breakwaters and piers. System of French engineers, of selecting and arranging the materials in three different classes, xviii. 107, 138.—Construction of artificial blocks of béton, 108.—Cost of the mole of La Joliette, Marseilles, 138.—Mole at Algiers, 137.—Suggested disintegration of the artificial blocks of béton, and observations on those at Algiers, by M. Ravier, 139.—Digue, or breakwater, at Ocherbourg, 140.—Cost of the Admiralty pier at Dover, 141.—Form and materials for breakwaters, xix. 668.—Use and cost of béton blocks at Algiers and at Marseilles, 668.—Proposed substitution of a gridiron, or wave screen, for the usual perpendicular, or sloping pier of masonry, 669.

Buoys, keel, xx. 309.

Chesil Bank, xii. 550.

Coasts, &c. Configuration of the coast of Norway, and of the western coasts of Ireland and Scotland, vii. 411.

Coffer-dam at Great Grimsby, ix. 11.—Construction of large coffer-dams, xvii. 553.

Colliers, screw, for the supply of coals to London, xvii. 406.

Dock-entrances, particularly those for the proposed docks at Sunderland, vii. 179, 180.

Docks. "On the progressive construction of the Sunderland docks," xv. 418.—Remarks, 445.—Effects produced by the new groynes placed seaward of those originally constructed, 445.—Construction of the coffer-dam in the tide-way of the river, and of the three channel coffer-dams, with the average

MURRAY.

- cost of the latter, 446.—Dimensions and effect of the scouring conduits, 447.—Quantity of water available for scouring, 447.—Effect of an experimental trial, 448.
- Dock-gates at Sunderland, particularly the cast-iron heel posts, the rollers and the roller paths, xviii. 477.—Wrought-iron caisson at the Victoria (London) docks, 478.—Shipment of coals at the Tyne docks, 505.
- Engines, friction of, ii. (1843) 71, 78.
- Foundations. Modes of checking a flow of water, or leakage, in excavations, xvii. 405.
- Harbour and docks at Sunderland. Groynes on the South Rocks, for constructing the new docks, viii. 194, *et seq.*—Set of the tide, the bay for beaching vessels, and rebuilding of the old south pier, 194.—Wave trap, 198, 200.
- Harbour of Blyth, xviii. 97.
- Harbours of refuge. Form and cost of breakwaters applicable to, xviii. 104.—Work under low-water, 105.—Superstructure, 106.
- Lighthouses. "Account of the removal of the lighthouse at Sunderland," iii. 342.
- Lock-gates. Plan of a sliding gate, proposed by M. Singels in 1839, xiii. 458.—Application of hydraulic power to the opening and shutting of lock-gates, xviii. 505.
- Locks. Old Ford, cast-iron pointing-cill of, xvii. 405.
- Mines. Ventilation of, and means of improving, a coal mine at Monkwearmouth, belonging to Messrs. Pamberton, vi. 207.—Origin of, and various improvements in, the miners' safety-lamp, 208, 212.—Government interference, 209.
- North Sea. "On the North Sea; with remarks on some of its friths and estuaries," xx. 314.—Remarks, 336.—Winds of the North Sea, and tides on the coast of Holland, Denmark, Jutland, and Norway, 336.—Formation of the Dogger bank, 367.

MURRAY.

- Rain-gauges, proper positions for placing, vii. 277.
- River Severn. Works at the Upper Lode, near Tewkesbury, xix. 584.
- River Wear. "An account of the progressive improvement of Sunderland harbour and the river Wear," vi. 256.—Remarks, 277.—Tides in the river, 277.—Effects of scour, 278.—Dredging, 279.—Deposits in, 281.—Construction of the wooden piers at the mouth of the river, xviii. 98.
- Rivers and estuaries. Relative advantages of groynes and training walls, for the improvement of, xii. 13.—Relative value of land water and of tidal water in scouring a river channel, xx. 16.
- Screw moorings, vii. 141.
- Sea defences. Preservation of coast land, by warping, by means of groynes, vi. 143.—Construction of groynes, 144.—Slopes faced with stone pitching for sea defences, 144.—Abrasion of materials in submarine constructions; the sandstone glacis in the harbour of Walker, the accumulation of shingle by groynes, and the sea defences on the coasts of Holland, vii. 199.—Groynes for the new docks at Sunderland, viii. 195.—Effect of, in arresting the travel of gravel and other substances, 196.—Effect to be anticipated hereafter, 197.—Cost of, and reasons which determined the inclination of the crest, and the direction in plan, 198.
- Shingle, movement of, at great depths, under water, xii. 551.
- Tides. Phenomenon of the tide in the Bay of Fundy, xx. 24.—Flood tide passing round the Isle of Wight and along the adjacent coast, and rise and fall of the tide at Southampton, 362.—Tidal observations along the coasts of Schleswig and Jutland, 363.—Tides of the Frith of Forth, 365.—Dr. Whewell's co-tidal lines, 366.—Tidal observations at Copenhagen, and saltness of the water in the chalk there, 367.—Rise of tide at different places from Kinaird Head to Lynn Deep, 370.—Difference in the force of the current in

MURRAY.

the Frith of Tay and at the Hamoaze, 388.

Water, discharge of. Assumption that tubular pipe drains are capable of discharging greater quantities of water than brick sewers, xii. 53.—Experiments at Hitchin to ascertain discharge, 54.—Results of experiments for ascertaining the actual delivery of water, by pipes of small and of large dimensions, compared with the discharge calculated by several formulae, 54.—Table of discharges, &c., 55.—Formulae employed in the calculations of the table, 56.

Water, flow of. Quantity of water passing along the canal of Marseilles, and its velocity at different points, xiv. 215.

Water supply. Saltness of the water in the chalk at Copenhagen, xx. 368.

Waves. Strength of, at the Skerryvore lighthouse, vii. 412.—Instances of injury sustained by nearly perpendicular walls, 412.—Depth below the surface to which the agitation of the sea extends, 413, 414; xix. 669.

MURRAY, J. E. [Election, ii. (1842) 122; resignation, xiii. 134.]

MURRAY, R. [Election, ix. 182.]

MURRAY, W. [Election, xviii. 406.]

MUSSET, D. [Election, i. (1838) 5; memoir, vii. 11.]

Fuel, use of peat, i. (1839) 29.

MYLNE.

Gold. Direction of the different mountain ranges of primary rocks, xv. 65.—Uniform tendency of primary rocks to run coincident with the magnetic meridian, 65.

Iron for railway purposes, i. (1838) 17.

—Analysis of a portion of the iron heel-plate of the stern-post of the 'John Bull' steam-vessel, i. (1839) 80.

— "Analysis of a piece of the iron heel-post converted by the action of sea-water into a substance resembling plumbago," i. (1840) 8.

— "Experiments upon cast and malleable iron at the Milton ironworks, Yorkshire, in February, 1843," ii. (1843) 126.—Remarks, 130.—Anthracite iron 130.

Smoke, 'Palmerston furnace' for the prevention of, xiii. 411.

MYLNE, R. W. [Telford medal and premium, i. (1840) 7.]

Canal and aqueduct of Marseilles, xiv. 211.—Velocity of water in channel of, 218.

Water supply. "On the supply of water from Artesian wells," i. (1839) 59.

MYLNE, W. C. [Election, ii. (1842) 184; Member of Council, iii. 66; iv. 62; v. 142; vi. 46; vii. 56.]

Wells, ii. (1843) 59.

MYLNE, W. C., Jun. [Election, vi. 213.]

N.

NAPIER.

NAPIER, A.

Automaton balance, as to his being the constructor of the, (Oldham, T.), ii. (1843) 121; (Cotton, W.) 124.

NAPIER, Captain Sir C.

Steam navigation, &c. Working of the 'Great Britain' steam-ship with the screw-propeller, iv. 166, 167.—War steamers, 168.

NAPIER, J. R.

Ships and steam vessels. Law regulating the size of the chain-cable and the weight of the anchor to the given ship, xvi. 308.

NAPIER, R. [Election, i. (1840) 28.]

NAPOLÉON, H.R.H. Prince Louis.

Junction of the Atlantic and Pacific oceans. Various projects for effecting, vi. 427.

'Napoléon' steamer, description of, with screw propeller, iii. 77.

NASH, F.

Girders. "Description of a new system of trussed girder, of wrought and cast iron, for bridges," iii. 102.

NASMYTH, G. [Election, iii. 66.]

NASMYTH, J.

Iron. Experiments on wrought iron (Taylor, J.), ii. (1843) 93.—Quality of Scotch hot-blast iron, 182.

Mirrors. "A mode of bending discs of silvered plate glass into concave or convex mirrors by means of the pressure of the atmosphere," i. (1840) 31.

Nasmyth's steam pile-engines used in constructing the river wall at the Tyne docks, xviii. 494, *et seq.*

National defences, the, (Bidder, G. P., Jun.), xx. 391.—*Vide* Defences, national.

Naval architecture, *Vide* DEFENCES, NATIONAL; NAVAL CONSTRUCTION; SHIPS and STEAM VESSELS; and STEAM NAVIGATION.

Naval arsenal, the late Mr. Rennie's design

NAVAL CONSTRUCTION.

for a grand, on the Thames, at Northfleet, v. 40.

NAVAL CONSTRUCTION.

Combination of iron and wood in the construction of ships (Henderson, Capt.), xiii. 36.

Copper sheathing, protectors for, of cast iron, tried on board the 'Magicienne' frigate (Galloway, E.), iii. 87.

Form of ships in relation to the power employed, illustrated by the trials of the 'Flying Fish' (Griffiths, R.), xvi. 344.

Iron vessels. "A tabular statement of the dimensions and proportions of forty iron vessels." By Lieut. E. N. Kendall, i. (1841) 146.

—References to Mr. J. Grantham's work, "Iron as a material for ship-building" (Wilkinson, J. J.), ii. (1842) 168.—Durability of, ii. (1843) 178, 179.—Strength of, as instanced by the 'Vanguard' and 'Great Britain' (Guppy, T. R.), iii. 306.—Coincidence between the strength of iron steam vessels and the wrought-iron tube proposed by Mr. R. Stephenson for traversing the Menai Straits (Vignoles, C.), 306.—History of the introduction of iron for the construction of vessels (Rennie, Sir J.), v. 96; (Field, J.), vii. 35, 39.—General employment of iron in ship-building, and its value in increasing the strength of vessels (Henderson, Capt.), xiii. 35.

Oars, upwards of 50 feet in length, used by the Chinese (Henderson, Capt.), xiii. 36.

Ship-building in America and in England (Eldridge, Capt. A.), xiv. 408; (Russell, J. S.), 413.

Trenails, for shipbuilding, i. (1841) 86.—Compressed ditto, 86, 87.

Water-tight bulkheads, ii. (1843) 179, 180; iv. 178, *et seq.*

NAVIER.

Vide also DEVENNES, NATIONAL; SHIPS and STEAM NAVIGATION; and STEAM VESSELS.

NAVIER, M. [Decease, i. (1837) 7.]

Navigation of the river Newry, on the improvement of the (Rennie, Sir J.), x. 277.
— and drainage works, description of the, on the tidal portion of the river Lee (Beardmore, N.), xiii. 241.—Ditto, on the second division (Despard, R. C.), xvii. 386.

Navy, Royal, application of steam to, xiv. 98.—Reliance to be placed upon, in case of invasion, xx. 393.—Construction and character of, for different services, 400, 423, *et seq.*

NAYLOR, W.

Steam-hammer, single, or double acting, xvi. 307.

NEATE, C. [Election, vi. 134; Council premium, x. 66.]

Coffer-dams. "Description of the coffer-dam at Great Grimsby," ix. 1.

NEILSON, J. B.

Iron. Process of smelting with heated air (Farey, J.), ii. (1843) 129.

NEILSON, W. M. [Election, xix. 489.]

Nelson Column, scaffolding used in erecting, (Grissell, T.), iii. 203.

Nene embankment, vi. 122.

NEPVEU, O., M.A. [Election, xiii. 383.]

Foundations under water. Notice of his Paper 'Note sur les Fondations en Rivière,' x. 365.

NEON, M.

Fire-arms. Mode of placing detonating caps on the nipple of a rifle, or a musket, xiv. 189.

NESHAM, W. J. [Election, xx. 586.]

NETHERWAY, —.

Pipes. Experiments for ascertaining the strength of earthenware pipes, xii. 59.

NEUMANN, G. [Election, xvii. 483.]

Neutral axis, experiments for determining the position of, in rectangular beams of cast and wrought iron and wood (Colthurst, J.), i. (1841) 118.

—, ditto, in glass, xvi. 72.

— *Vide also BEAMS.*

New Cross, cutting and slip, Croydon railway, iii. 135.

NEWTON.

New red-sandstone, and how far it is similar to chalk, ix. 374.

NEWALL, J.

Railway breaks, particularly his combination of breaks, xvii. 168.

Newall's continuous and self-acting break, report of Colonel Yolland, xix. 491.

NEWALL, R. S., and Co.

Wire-rope, testing of their, on Oldham incline (Laws, Captain), x. 248.

NEWLANDS, J. [Election, vii. 366.]

Drainage of Liverpool, xii. 90.

Roads. Extract from his Report, for 1853, on the sewerage, paving, &c., of the borough of Liverpool (Haywood, W.), xiii. 232.—Comparative cost of keeping in repair a macadamized road, and paving, 238.—Cost of macadamizing at Liverpool, 240.

Newry, population and trade of, x. 239.

NEWTON, —.

Drainage of Hitchin, xii. 95.

NEWTON, A. V. [Telford medal, xi. 87, 118.]

Patent laws. "An inquiry into the nature of patent-law protection, with a view to the better appreciation and security of the inventor's rights," x. 192.—Remarks, 212.—Patent laws based upon the spirit of justice, and amelioration of those laws should refer solely to the granting of patents, without touching upon their validity when granted, 212.

NEWTON, C.

Bridges, suspension, iv. 295.

NEWTON, I.

Rotation of the earth, his mechanical test for demonstrating the, x. 321.

NEWTON, J. [Election, xvi. 226.]

NEWTON, W. [Auditor, vi. 57; vii. 74.]

Axles, hollow, ii. (1843) 94.

Brickmaking, ii. (1843) 152.

Coasts, &c. Remains of Roman castrum, at Lyme, xi. 205.

Machines. Martin's improved Jacquard-machine, xiii. 368, 369.

Marine worms. Method of preventing the attacks of, at Herne Bay pier, ix. 45.

Meat, Mr. Oldham's process for preserving, ii. (1842) 82.

NEWTON.

Paper, Mr. Oldham's process for wetting, ii. (1842) 82.

Patent laws, improvements in the administration of, x. 217.

Railway, atmospheric, iii. 269.

Stone, artificial. Difference between porosity and absorption, and quality of the artificial stone, made with a silica base, vii. 70.

Timber, Kyanising, ii. (1842) 82.

Warming and ventilating. Description of Joyce's heating apparatus, i. (1838) 11.

Wool, cleansing, under exhaustion, ii. (1842) 82.

NEWTON, W. E.

Permanent way. "Account of the method employed in constructing the permanent way of the Philadelphia and Reading railway, U.S.; with a description of a wrought-iron joint chair and fastenings for the rails, as employed on the Baltimore and Susquehanna and other railways in the United States," vi. 59.—Remarks, 76.—Extracts from American Railroad Journal, 76, 79.

Steel, manufacture of puddled xviii. 341, 342.

NICHOLLS, N. [Auditor, i. (1837) 20.]

NICHOLSON, —.

Scaffolding, iii. 206.

NICHOLSON, R. [Election, i. (1838) 15; memoir, xv. 93.]

Locomotive engines. Distance traversed by, before getting up their speed, and relative convenience of stopping trains on locomotive and atmospheric lines, iv. 286.

NICHOLSON, W. [Election, i. (1838) 26; resignation, viii. 10.]

Nieuwediep, harbour of, works at the, vi. 104.

NIXON, C. [Election, ii. (1842) 56; Walker premium, ii. (1843) 7.]

Permanent way. Asserted rapid destruction of railway switches and crossings, xiv. 483, 486.

Roofs, covering, with Lord Stanhope's composition, ii. (1843) 96.

Tunnels. "Description of the tunnels, situate between Bristol and Bath, on

NORTH SEA.

the Great Western railway, with the methods adopted for executing the works," ii. (1842) 138.—Remarks, 139.—Expense of working by driftways, 139.

NOBLE, Captain, R.A.

Artillery. Computed initial velocity of the Armstrong projectile, xix. 421.—Method, adopted by the Ordnance Select Committee, of calculating rect-angles, exhibiting comparative error in different guns, xx. 531.

Norfolk estuary works, xii. 13; xix. 91, *et seq.*

NORMAN, M.

Screw-propellers, iii. 78, 81.

Normand's saw for cutting out ships' timbers, xvii. 26.

NORRIS, R. S. [Election, xiii. 364.]

NORTH SEA.

"On the North Sea; with remarks on some of its friths and estuaries." By J. Murray, xx. 314.—Charts should be contoured and coloured, to represent the different depths of the sea, 314.—Similarity of outline of the western shores of Ireland, Scotland, and Norway, 315.—Course of the great stream of flood from the Atlantic, running southward along the coast of Scotland and the east coast of England, with the time of high water, at the full and change of the moon, and the tidal range, at different places, 316.—Velocity of the tidal wave, from Kinnaird Head to the Thames, 318.—Meeting of this current with the stream of flood issuing from the Straits of Dover, 318.—Captain Hewett's observations for determining the position of the 'node' point in the North Sea, where there is no rise or fall of the tide, 318.—Meeting of the tides on the Flemish and Danish coasts, 319.—Gradual shoaling of the North Sea, and silting up of the mouths of the Rhine and the Schelde, from the debris of the littoral, 319.—Deposits of silt over the fen districts of Lincolnshire and Cambridgeshire, 320.—Inroads of the waters of the North Sea, on the coast from the Schelde to

NORTH SEA.

the northern part of Jutland, 321.—Effects produced by the action of the tide amidst the islands and straits in the north of Scotland, and on the mouths of some of its estuaries, 322.—The Murray Frith, 323.—The Frith of Dornoch, 323.—Rainfall at Aberdeen, Arbroath, and Elgin, and quantity of water flowing off the ground, 324.—Velocity of the stream of ebb out of the estuary, 325.—Bar at the mouth of this frith, 325.—The Frith of Inverness, 327.—The Frith of Cromarty, 328.—Contents of the estuary, and surface velocity of the flood and ebb through the entrance, 329.—Under-currents, 329.—Formation of the bar, or great bank of sand, at the entrance, 332.—Effect which would be produced by the erection of a pier at right angles with the coast, and connected with the South

NYCTOSCOPE.

Suter, 333.—Information derived from the examination of these three contiguous friths, 334.

Discussion.—Bidder, G. P., 335, 344, 371.—Bremner, A., 358.—Brooks, W. A., 345, 355.—Bruff, P., 358.—Burstal, Capt., 346, 362.—Curtis, J. G. O., 347.—Giles, A., 345, 347.—Hemans, G. W., 361.—Harrison, J. T., 337.—Hawksley, T., 361.—Jackson, R. W., 351, 362.—Moorsom, Capt. W. S., 356.—Murray, J., 336, 362.—Rawlinson, R., 360.—Redman, J. B., 356.—Russell, J. S., 344, 346.

NORTHAMPTON, Marquis of. [Election, ii. (1842) 184; memoir, xi. 98.]

Numbering and dating bank-notes, machines for, (Oldham, T.), ii. (1842) 166.

Nyctoscope, an instrument for enabling gunners to maintain a fire upon any given object after nightfall, xix. 421.

O.

OAR-MAKING MACHINE.

Oar-making machine in Chatham dockyard, xvii. 33.

Oars, upwards of 50 feet in length, used by the Chinese, xiii. 36.

O'BRIEN, Captain D. [Election, vi. 431.]

Bridge at Ballysimon, on the Waterford and Limerick railway, xi. 12.

Coasts, &c. Nature and extent of Romney Marsh, and means adopted for preventing inroads of the sea, vi. 478. — Coast between Dover and Hastings, including Romney Marsh, xi. 208. — Destruction caused by sandhills, and necessity for keeping them protected by 'bent' grass, and orchideous plants, 210. — Extract from Messrs. Roach Smith and J. Elliot's report on excavations at Lyme, 211. — Position of different-sized pebbles on beach, 219.

Coffer-dam, at Great Grimsby, site of the, ix. 13.

Locks and keys. Davis's 'Cabinet' locks, ix. 339. — Locks of Millbank and Pentonville prisons, 340.

Shingle, movement of, xi. 208.

OGLVIE, A. [Election, ix. 375.]

OGLVIE, R. [Election, xii. 352.]

O'GORMAN, G.

Junction of the Atlantic and Pacific oceans. Comparative advantages of a railway and ship canal across the Isthmus of Panamá, and on M. Garella's survey, ix. 71.

O'HAGAN, H. [Election, xi. 477.]

Ohm's formula for determining the velocity of the passage of a current of electricity, xvi. 223; xx. 37.

OHREN, M. [Election, xviii. 231.]

Oil, products of combustion of, ii. (1843) 185.

Oil gas, introduction of, v. 63.

Oil of tar, Bethell's process for preserving timber with, ii. (1842) 88.

OLDFIELD, Lieutenant J. R. [Election, ii. (1842) 72.]

ORMISTON.

Railways. "An account of the railway constructing between Liège and Verviers, Belgium," ii. (1842) 141.

Timber. Renwick's patent for saturating, with coal oil, ii. (1842) 68. — Ravages of the 'Teredo navalis,' 68. — Use of steam in the process of Kyanizing, 84.

OLDHAM, G. A. [Election, i. (1839) 51.]

OLDHAM, J.

Docks, size of sewer outlets, and magnesian limestone used in the construction of the Sunderland, xv. 451.

Drainage of land. Ancholine drainage, iv. 200.

Lock-gates, iii. 256.

OLDHAM, J. [Memoir, i. (1841) 14.]

Steam navigation, &c. Feathering paddles used on board the 'Aaron Manby,' iv. 184.

Warming and ventilation, i. (1837) 43, 44.

OLDHAM, T. [Election, i. (1841) 83; Telford medal, iii. 6.]

Balance. "Description of the automaton balance for weighing coins, invented by William Cotton, Esq., Governor of the Bank of England," ii. (1843) 121. — Remarks, 123. — Accuracy of the automaton balance, 123.

Bank-note paper, wetting, under exhaustion, ii. (1842) 82.

— "On the introduction of letterpress printing for numbering and dating the notes of the Bank of England," ii. (1842) 166.

O'NEILL, J.

Railway trains, iron telegraph for, xvii. 539.

Ordinance. *Vide* ARTILLERY.

Ordinance survey of the British isles, v. 112.

ORKNEY, Earl of. [Election, i. (1839) 66.]

ORMISTON, T. [Election, xx. 586.]

Ferries, steam, worked by chains, xx. 388.

OUDEDIEP.

- River Clyde, improvements of the, and their effect on the land floods, xix. 110.
 Oudediep Swin, vi. 105.
 Outfalls, on arterial drainage and, (Gran-
 tham, B. B.), xix. 53.
 OWEN, —.
 Locks and keys. Attempts to pick one
 of Chubb's locks, ix. 341.—Mechanical
 contrivance for comparing the merits
 of Bramah's and Chubb's locks, 341.
 OWEN, Captain H. C., R.E. [Election, xi.
 241.]
 OWEN, L. D.
 Machinery, American, for the conversion
 of wood, and relative merits of wooden
 and iron framework, xvii. 47.—Forms

OXLAND.

- of the teeth of saws, 48.—Difficulty
 in getting the planing-machine to do
 the work of the smoothing-plane, 48.
 OWEN, Professor.
 Abattoirs of Paris, and arrangements of
 the markets; butchers' trade in Lon-
 don, viii. 75, 79.
 OWEN, W. [Election, xvi. 309.]
 OWEN, W. G. [Election, xx. 106.]
 OWER, C. [Election, iii. 248; resignation,
 viii. 10.]
 Owers' light, between the Thames and
 Spithead, xv. 23.
 Oxland's process for removing wolfram from
 tin, xvii. 213.

P.

PADDLE-WHEELS.

Paddle-wheels, first application of, to the propulsion of boats, v. 82.

— and the screw-propeller, on the relative efficiency of, (Armstrong, R.), xvi. 327.

PAGE, —.

Arches, ancient, found among Palesgic remains at Onidua, iii. 111.

PAGE, Colonel.

Professional MSS., &c., present by Mrs. Page, of his, i. (1837) 6.

PAGE, E.

Railway companies. Report on some points connected with the relations between the Post-office department and railway companies, xv. 459. — Reply of Mr. R. Stephenson, M.P., President, to ditto, 470.

PAGE, G. T. [Election, i. (1841) 116; Walker premium, ii. (1842) 9; memoir, x. 91.]

Machines. "Description of the piling machine used at the Montrose harbour works," iii. 197.

PAGE, T., and AENOTT, Dr.

Drainage of towns. Extract from their reports, on the prevalence of disease at Croydon, and as to the plan of sewerage, xii. 44.

Page's (Prof.) electro-magnetic engine, xvi. 391.

Paint, for protecting iron, ii. (1843) 176. — For poisoning molluscous animals, &c., on the bottoms of ships, 176.

Painting-machines used in the construction of the building for the Exhibition of all Nations in 1851, x. 161.

PALMER, O. M.

Colliers, ballasting, and number of voyages and cost of working screw, xiv. 365.

PALMER, G. H.

Air, friction of, in pipes, i. (1837) 43.

Permanent way. Compressed keys, iv. 56.

PALMER.

Pump-valves, iii. 97.

Steam. "On the application of steam as a moving power, considered especially with reference to the reported duties of the Cornish and other engines," i. (1837) 38.

PALMER, H. R. [Vice-President, i. (1837) 15; (1838) 20; (1839) 27; (1840) 36; (1841) 52; ii. (1842) 51; (1843) 67; iii. 66; memoir, iv. 6.]

Boats, experiments on canal, ii. (1843) 114.

Bridges. Destruction of a suspension bridge in America, i. (1841) 128.

Docks. Extracts from his "Report on the proposed eastern entrance to the London docks," including remarks on the entrances to the Bristol and the Runcorn docks, on the docks in the Port of London, and on the entrances to the principal public docks, and the labour entailed at the graving-docks on account of their position (Redman, J. B.), vii. 165.

Harbours. "Description of the harbour of Port Talbot (Glamorganshire)," ii. (1842) 188.

Horse-power, ii. (1843) 114.

Locks, i. (1839) 79.—Port Talbot, 79.

Professional MSS., &c. Present, by Mrs. Palmer, of his papers, drawings, and models, iv. 5.

Sea walls, forms of, proposed by Colonel Jones, ii. (1842) 129.

Ships and steam vessels. Mallet's mode of raising ships, ii. (1842) 136.

Timber, Kyanizing, by pressure, ii. (1842) 82, 83.

Water supply. Mr. Clutterbuck's views as to the ready flow of water through chalk, ii. (1842) 163.

PALMER, J. B. [Election, xi. 68.]

PALMER, W. [Resignation, i. (1837) 7.]

Palmer and Perkins' elliptical disc valve, iii. 91, 93.

PAPER.

- Paper, Mr. Oldham's process for wetting, ii. (1842) 82.
- PAPIN, Dr.
Smoke, allusion to his plan for consuming, (Simpson, J., Jun.), xiii. 384.
- PAFWORTH, J. W.
Bells, striking, and composition of old, xix. 18.
Water supply. Means adopted for supplying New York with water, xiv. 209.
—Incrustation of ancient water-courses, 210.
- PARK, J. H. [Election, xx. 106.]
- PARKER, —.
Drainage of towns. Probable cause of failure of tubular drains, xii. 66.
Parker's patent for cements, xvi. 433.
- PARKES, J. [Telford medal, i. (1839) 6; (1841) 6; Member of Council, i. (1840) 36; (1841) 52.]
Agriculture. Use of ammonia for agricultural purposes, ii. (1842) 68.—Mannures, 69.
Artillery. Regularity of vibration in cannons, and in gun-barrels, ii. (1843) 107.
Boats, passage, for inland navigation, i. (1840) 29.
Boilers, annealing tubes for water-gauges on, i. (1840) 40.
Brickmaking, ii. (1843) 151, 155.—Quantity of water evaporated from bricks in drying and burning, 155.
Canals, i. (1838) 28.
Ferries. Hamoeze floating bridge, i. (1838) 24.
Fuel. Relative heating effects of coke and coal, i. (1838) 29.—Ditto for melting glass, 40.—Use of peat fuel, (1839) 30.—French peat, as fuel, 68.—Combustion of different kinds of fuels, (1840) 67.
Indicators. Moseley's, ii. (1841) 110.—Results of the trials at the Old Ford engine, 110.
Iron. Experiments on wrought iron at the Milton iron-works, ii. (1843) 129, 131.
Lighthouses, revolving lenses in, i. (1840) 24.
Pump-valves, ii. (1843) 199.

PARKES.

- Railway axles, ii. (1843) 107.
- Ships and steam vessels. Performances of the 'Great Western' steam-ship, i. (1841) 71.
Steam. Application of the expansive power of steam in Cornish engines, i. (1838) 9.
— "On the action of steam as a moving power in the Cornish single-pumping engine," i. (1840) 75.—Remarks, 80, 82.
— "On the percussive action of steam and other æriform fluids," i. (1841) 149.—Remarks, 152.—Expansion of steam, 152.
Steam boilers. "On the evaporation of water from steam boilers," i. (1838) 17, 28.
—, causes producing the explosion of, i. (1841) 106.—Effects produced by the breaking-up of the scale in the salt pans, 106.—Steam generated by iron plates at different degrees of heat, 107.—Cause of the explosion of the boiler on board the 'Union' steamer, at Hull, 107.—Ditto of a steam vessel at Norwich, 108.—Ditto at Passy, 108.—Ditto at Camden Town, 109.—Relative liability of the boilers of high pressure and other engines to explode, 109.—Practice in the coal districts, 109.—Use of hammered plates for salt pans, 110.—Causes of the explosion of a boiler on board Steele's steam vessel at Lyons, 110.—No reason given for the projection of heavy boilers from their seats, 111.—Notice of explosions at Durham, and Oraver mine in Cornwall, 111.—Boilers at a red heat without explosion, 111.—Causes of ruptures and projections of vessels, from explosions of hydrogen gas, 111.—Explosion at Messrs. Stocks' works, near Manchester, 111.—Ditto at Messrs. Rhodes' sugar-house, near London, 112.—Small number of explosions of boilers in Thames steamers, and on the formation of hydrogen gas in boilers, 113.
Steam engines. "On steam boilers and steam engines," i. (1839) 54.

PARKES.

- Steam engines. "On steam engines, principally with reference to their consumption of steam and fuel," i. (1840) 6.—Remarks, 9.—Steam boilers, 9.—Duty of steam engines, 24.
- Wells, sinking, in India, ii. (1842) 64.
- PARKES, W. [Telford medal, vi. 2; election, x. 162.]
- Breakwaters, form and construction of, xviii. 119.
- River Severn. "On the estuary of the river Severn," v. 300.
- between Worcester and Tewkesbury, and system pursued for its improvement, xix. 538.
- Sea-wall at Alderney, x. 276.
- Parkinson's diaphragm water-meter, xiii. 425; xvi. 62.
- (W.) water-meters, xiii. 435.
- PARNELL, Sir H. [Memoir, ii. (1843) 11.]
- PARRY, Rear-Admiral Sir W. E. [Election, i. (1839) 42; memoir, xv. 90.]
- PARSON, G. J.
- Steam, system of superheating, by means of pipes, xix. 478.
- PARSONS, J. M. [Election, i. (1839) 38.]
- PARSONS, P. M. [Election, xi. 148.]
- Fuel. Possible maximum evaporative efficiency of 1 lb. of fuel, xii. 426.—Depth of fuel in locomotives, 426.
- Locomotive engines, economical use of steam in, xii. 429.
- Permanent way. "On some recent improvements in the permanent way of railways," xvi. 259.—Remarks, 266.—Class of fastenings used previous to the introduction of the wood-key, 266.—Defects of screw-bolts and nuts for fastening together the parts of the permanent way, 266.—Advantage of iron wedges, in connection with end-grain wood cushions, for that purpose, 267.—Objections to the chair system, 267.—Adams' suspended girder-rail, 268.—Comparative cost of ditto, and of ordinary rails with chairs and fastenings on his system, 268.
- Remedy for the shrinkage of wooden railway keys in hot climates, xviii. 424.
- Parsons' (P. M.) cast-iron chair, wrought-iron wedge, and end-grained wood

PASLEY.

- cushions, xvi. 238.—Trial of, on the Great Northern railway, 275.
- PARSONS, W. [Memoir, xvii. 103.]
- PASLEY, Lieutenant-General Sir C. W., R.E.
- Arches, investigations for determining the conditions of stability of, v. 465.
- Beams. Experiments upon the brick beam erected at the Great Exhibition, Hyde Park, xi. 503.
- Blasting under water. "On the application of Bickford's fuzes to blasting under water," i. (1838) 33.—Remarks, 34.—Tamping, 34.
- Use of Bickford's patent fuze, iv. 371.—Use of voltaic battery for firing gunpowder under water, xv. 337.—Application of Bickford's fuzes to blasting under water, 341.
- Bridges. "On the state of the suspension bridge at Montrose after the hurricane of the 11th of October, 1838, with remarks on the construction of that and other suspension bridges, in reference to the action of violent gales," i. (1839) 32.
- Wrought-iron lattice bridge on the Dublin and Drogheda railway, iii. 64.—Cast-iron swing bridge over the river Wensum, at Norwich, v. 438.—Torksey tubular bridge, ix. 263.—Effect of a rolling weight in motion, 268.—Value of the continuity of the girders, and results of the want of it in the Dee Bridge, at Chester, 269.
- Comments, observations and experiments on, i. (1837) 17.—Various kinds of artificial, 19.—Manufacture of artificial, xi. 502; xvi. 443.
- Coasts, action of the sea upon, ii. (1842) 180.
- Concrete, first employment of, in England, xvi. 444.
- Decimal coinage, &c., xiii. 302.—Difficulties in the introduction of the French system of coins, weights, and measures, 303.—Instances of the commercial advantage of the decimal system, 303.
- Diving apparatus. Operations against the wreck of the 'Royal George,' xv. 328, 330.—Recommendation to Admiralty, that some petty officers and sea-

PASLEY.

- men of the gunnery ship 'Excellent' should be trained as divers, 329.—Diving apparatus, 329.—Invention of the open diving dress, 337.
- Diving bell, results of experiments on the, i. (1839) 68.—Unsteadiness of, vii. 414.
- Exhibition in 1851, construction of the building for the, x. 180.
- Fire-arms. Merits of Colt's revolvers, as subsidiary arms, for troops engaged against savage tribes, xi. 55.
- Fire-proof buildings. Report of Sir Henry De la Bèche, and Mr. T. Cubitt, on the fall of the cotton-mill at Oldham, and also part of the prison at Northleach, vi. 222.—Protecting metal against the effect of fire, by a thin coating of brickwork, viii. 157.—Fire-proof buildings, and the materials for their construction, 162.
- Friction, ii. (1843) 78.
- Iron. Changes in the cast iron found in the 'Royal George,' iii. 86.—Effects of salt water on cast iron, ix. 194.
- Locomotive engines. Construction of, particularly as to the position of the driving-wheels, viii. 254.—Origin and progress of, 254.—Unsteadiness of long-boiler engines, 255.—Outside-cylinder engines, 258.
- Permanent way of the Dublin and Drogheda railway, and machine used for preparing the sleepers to receive the rails, v. 240.—Superiority of the bridge rail over the T rail, and of longitudinal over transverse sleepers, viii. 271.
- Railway accidents, causes of, xi. 475.
- Railway, atmospheric, iii. 274.
- Railway axles, ii. (1843) 92.—Handcock's, 167.
- Railway carriages on the Dublin and Drogheda railway, v. 243.
- Railway cuttings, iii. 145, 148, 152.—Constructions for retaining the sides of, 367.
- Scaffolding, iii. 211.
- Sea-walls. Injury sustained by the sea-wall along a portion of the South Devon railway, vii. 192.—Preference for vertical walls, as sea-defences, in deep

PATENTS.

- water, materials of which they should be composed, and method of building, 411.
- Timber. Specific gravity of water-logged timber, ii. (1842) 86.
- Ventilation, system of, adopted in military mining, vi. 190.
- Viaduct, Dinting Vale, and use of cement instead of mortar for arches, v. 219.
- Waves, depth to which the action of, extends, vii. 198.
- Wrecks. Destruction of submerged vessels by gunpowder, xv. 340.—Extracts from the 'United Service Journal,' as to his operations in the removal of wrecks by subaqueous explosions, 342.
- Pasley's treatise on limes, cements, &c., xvi. 433.
- PATEN, —.
- Wells. Statement that the water in the London wells has sunk, viii. 185.
- Patent slip, arrangement for raising ships of all classes out of the water, proposed to replace the, (Mallet, B.), ii. (1842) 135.
- PATENTS.
- Laws relating to. "An inquiry into the nature of patent law protection, with a view to the better appreciation and security of the inventor's rights." By A. V. Newton, x. 193.—As to policy of withholding from inventors the rights which are awarded them by the patent-laws, 193.—The protection secured by the Copyright Acts and the patent-laws, the same in kind, but the periods of commencement and duration differ, 194.—Who are, and who ought to be, entitled to possess themselves of patent grants, 196.—Reply to objection as to supposed indefiniteness of the statute regarding what is a proper subject for a patent, 197.—Cost of patent grants, 198.—Evidence against the policy of granting cheap patents, 200.—Does the present money payment act as a wholesome check to the growth of patent property, 200.—Act for the registration, for three years, of non-ornamental designs, or articles of novel form, or

PATERSON.

utility, 201.—Comparison between the number of patents applied for in England and those actually granted, 201.—Application of inventive faculty to the useful arts especially beneficial to Great Britain, 202.—Number of patents granted in France during the years 1847-8-9, 202.—Ditto in the United States, ditto, 203.—Much of the ingenuity of other countries lost to England, 203.—Territorial limits of patent grants form an important branch of inquiry, 204.—Notice of a suggestion for establishing an international recognition of the rights of inventors, 206.—Duration of patent grants, 207.—Results of the inquiry, 208.

Discussion.—Braithwaite, F., 216.—Carpmael, W., 213.—Haddan, J. O., 218.—Lloyd, J. A., 214.—May, C., 211.—Newton, A. V., 212.—Newton, W., 217.—Pellatt, A., 215.—Bitterbandt, Dr., 217.—Roberts, R., 214.—Rotch, B., 211.—Sidney, S., 215.—Varley, O., 215.—Webster, T., 209, 217.—Wordsworth, C., 210.

Patents. History of the institution of, (Rennie, Sir J.), v. 115; (Simpson, J.), xiii. 198.

PATERSON, P. [Council premium, x. 66; election, xi. 241.]

Lighthouses. "An account of the cast-iron lighthouse tower on Gibbs' hill, in the Bermudas," ix. 182.

PATON, J. [Telford medal, x. 66; election, xx. 586.]

Marine worms. Means for preventing their attacks, ix. 23.—Freedom from injury of a piece of Jarrah wood, 40.

Piers. "Description of the pier-head of the old Southend pier, and of the recent extension of the structure; with an inquiry into the nature and ravages of the 'Teredo navalis,' and the means hitherto adopted for preventing its attacks," ix. 23.—Remarks, 40.

PATRICK, J.

Marine engines. "Description of the engines on board the iron steam tug, the 'Alice,'" i. (1840) 54.

PATRIDGE, D.

PAVEMENTS.

Steam, use of superheated, xix. 471, 476. PAVEMENTS.

"An improved mode of paving streets." By E. Lomax, i. (1841) 181.

"On the present state of the streets of the metropolis, and the importance of their amelioration." By C. Cochrane, ii. (1843) 203.—Government commission for inquiring into the most effectual means of improving the metropolis, 202.—Cleansing the streets by hand and by machinery compared, 203.—Whitworth's machine examined, 203.—Losses of shopkeepers from dust, &c., 203.

"On the relative merits of granite and wood pavements and macadamized roads; derived from actual experience." By D. T. Hope, ii. (1843) 203.—Causes of the inefficiency of some pavements, 203.—Requisites of good pavements, 204.—Comparison of granite pavements with macadamized roads, 204.—Advantages of granite, 205.—Comparison of wood pavement with stone and with macadamized roads, 205.—Best position of the fibre of wood for resisting abrasion, 205.—Concrete substratum essential, 205.—Cohesion of the blocks, 205.—Absorption of moisture, &c., 205.—Weights drawn by a horse on various pavements, 205.

"Observations on the street paving of the metropolis; with an account of a peculiar system adopted at the London and North Western railway station, Euston-square." By W. Taylor, ix. 214.—Ordinary London pavements, 214.—Macadamizing, 215.—Description of the Euston pavement, 216.—Opportunities for cleansing it, 218.—Test of its strength and durability in Watling-street, 218.—Advantages of the use of small stones, 219.—Comparative cost of the two systems, 219.—Telford system of paving, 220.—Means suggested for at once improving the paving of the metropolis, 221.

Discussion.—Ansted, Prof., 225.—Barlow, P. W., 226.—Dockray, R. B., 226.—Haywood, W., 222, 229.—Holland,

PAXTON.

- W. H., 224.—Legg, M. O., 230.—Radford, W., 223.—Saunders, T., 228.—Taylor, W., 230.—Tennant, J., 229.
- Different modes of paving described (Rennie, Sir J.), v. 67.—Granite blocks, 67.—M'Adam's system, 67.—Wood blocks, 67.—Asphalte, 68.—Flags, 68.—Improvement of street paving in large towns (Simpson, J.), xiii. 197.—First cost and durability of the pavements in different streets of the City, 234, *et seq.* *Vide* also ROADS, and STREET CLEANSING.
- PAXTON, Sir J. [Election, x. 245; Member of Council, xiv. 97.]
- Exhibition in 1851, construction of the building for the, x. 172.
- Paxton roofing used in the construction of the building for the Exhibition of all Nations in 1851, x. 151.
- PAYNE, Dr.
- Ventilation. Apparatus for purifying the air in a diving bell (Faraday, Prof.), ii. (1843) 191.
- Payne's process for preserving timber, ii. (1842) 87.
- and Elmore's process for preserving meat, ii. (1842) 83.
- PEACOCK, R. [Election, viii. 261.]
- Locomotive engines used on the Manchester, Sheffield, and Lincolnshire railway, xviii. 67.
- PEARCE, J. C. [Election, xx. 375.]
- PEARCE, W. [Election, i. (1839) 54.]
- PEARSALL, T. J.
- Blasting. Insulation of wires in blasting operations, xv. 399.
- Mortar, hydraulic; use and value of iron in its composition, xvii. 438.
- Steam boilers, explosions of, xv. 298.—Agency of gunpowder in boiler explosions, 305.
- Water, M. Boutigny's experiments as to spheroidal form assumed by, xv. 297.
- PEARSE, G. [Election, i. (1840) 33.]
- PEARSON, O.
- River Thames, past and present condition of the, xv. 216.—As to whom the river belongs, and who is to blame for its present state, 216.—Recommendations contained in report of

PELLATT.

- Commissioners appointed by the Corporation of London in 1837, as to removal of shoals thrown up after the removal of Old London bridge, 218.—Claims made by Crown lawyers, to the improvement fund, as part of the hereditary revenues of the Crown, 219.
- PEARSON, S.
- Artillery. Construction of guns to withstand the greatest amount of internal pressure, xix. 394.
- Peat fuel, use of, i. (1839) 29.—For working iron, 29, 30, 87.
- , properties and composition of, (Williams, O. W.), i. (1839) 38.
- , French, i. (1839) 68.
- Peat moss, sea defences constructed with, (Stuart, Hon. M.), i. (1841) 140; vi. 483.
- PEEL, Right Honourable Sir R., Bart. [Election, ii. (1842) 184; memoir, x. 78.]
- PEBOE, J. S. [Election, ix. 182.]
- PELLATT, A. [Election, i. (1838) 9; Member of Council, (1840) 36; Auditor, iv. 61; v. 160.]
- Arches, especially those for the vaults of glass furnaces, v. 174.
- Brickmaking. Prosser's process of dry moulding by compression, ii. (1843) 149.—Quality of pottery clay, 149, 153.—Quality of bricks, 152.
- Drainage of the district south of the Thames, xiii. 97.
- Exhibition in 1851, design and construction of the building for the, x. 190.
- Fuel. "On the relative heating powers of coke and coal in melting glass," i. (1838) 39.
- Use of peat fuel, i. (1839) 81.—Coke fuel, 42; (1840) 40.—Combustion of different kinds of fuel, 67.
- Gas, London, viii. 232.
- Gas-meters, iv. 222.
- Glass. "On the manufacture of flint glass," i. (1840) 37.—Remarks, 89.—Prince Rupert's drops, 39.—Plate glass used in Nasmyth's pneumatic mirror, 40.—Annealing glass, 40.
- Horse power of two engines at a gas manufactory, x. 311.

PELLATT.

- Patents, dearness of, a great bar to improvements, x. 215.
- Stone, artificial, with a silica base, vii. 61, 65.—Difficulty of making large articles of terra-cotta, 63.
- PELLATT, F.
- Iron. "On the application of zinc by the process of electro-deposition, for the preservation of iron, as applied to engineering and other purposes," ii. (1843) 167.—Remarks, 169.—Description of the process, 169.
- PEMELL, E. [Election, xiii. 421.]
- Pendulum, Huygens' observations on the, and proposal to make the seconds pendulum the fundamental standard in metrology, xiii. 276.
- PENISTON, W. M. [Election, vi. 254; Council premium, xiv. 105.]
- Tunnels. "On the casualties of tunnelling, with examples," xiii. 475.—Remarks, 477.—Difficulty of sinking in sand, 477.—Reasons for not adopting an open cutting in several cases, 478.
- Penmaen-Mawr, sea-walls at, vi. 115, 124.
- PENN, J. [Memoir, iii. 13.]
- PENN, J. [Member of Council, xii. 112; xiii. 123; xiv. 97; xv. 76.]
- PENNY, A. [Election, xviii. 525.]
- PENROSE, F. C. [Election, vii. 250; Member of Council, x. 60.]
- Drawing instruments. Screw helicograph, or logarithmic spiral compass, and sliding helicograph, x. 245.
- Iron. Effect of extreme changes of temperature on iron and wood, xii. 268.
- Masonry, xvi. 437.
- Mortar. Durability of rubble walls when built with good mortar, x. 236.
- PENSON, T. [Election, i. (1839) 72; memoir, xx. 156.]
- Penstock, self-acting, or flushing machine, Salter's, xvi. 48.
- Pentagraph, Professor Wallace's, i. (1839) 65.
- PENTLAND, —.
- Viaduct of Ariocis, across a valley intersecting the line of the Via Appia, xiv. 235.
- PEPPER, J. H. [Election, iii. 101.]

PERMANENT WAY.

- PEPPERBOONE, F. S. [Resignation, xiii. 134.]
- Percolator, hydrostatic, Loysel's, for extracting colouring matters from dye-woods, for obtaining infusions, or extracts of vegetable substances, and for medicinal or other purposes, xiii. 416.
- PERCY, Dr.
- Furnaces, working of blast, xii. 375.
- Percy Main colliery, water raised per day at, ii. (1842) 171.
- PERDONNET, A. [Election, xx. 106.]
- PERKINS, A. M. [Election, i. (1840) 54.]
- PERKINS, C.
- Screw propeller. Changes induced in the metal of the screw propeller of the 'Napoléon,' iii. 85.
- PERKINS, E. M. [Election, ii. (1843) 105.]
- Marine engines, employment of high-pressure steam, working expansively, in, viii. 309.
- Mines. Ventilation of, vi. 189.—Partial lighting by gas of the Sherburn and Bedlington collieries, xvii. 12.
- Pump valves, iii. 93.
- PERKINS, J.
- Locomotive engines. "On locomotive engines and the means of supplying them with steam," i. (1837) 20.
- Pump valve, square, iii. 96.
- Screw propeller, iii. 84.
- PERMANENT WAY.
- Birmingham and Gloucester railway.
- "An account of the permanent way of the Birmingham and Gloucester railway." By G. B. W. Jackson, ii. (1842) 53.
- Bordeaux and Bayonne railway. "On the laying of the permanent way of the Bordeaux and Bayonne railway, through the Grandes Landes." By F. R. Conder, xvi. 371.—Aspect of the country, 371.—Specification for the work, 372.—Usual course of the operations pursued in the laying, 374.—Difficulties of communication, and desert nature of the scene of operations, 375.—Narrative of exertions to expedite the opening of the line, 376.—Climatological influence of the opening of the railway, 378.—Successful effort

PERMANENT WAY.

to redeem the district from the ague and the Landes fever now possible, 378.

Discussion.—Babbage, C., 384.—Beardmore, N., 383.—Berkley, G., 381.—Bidder, G. P., 385.—Bruff, P., 382.—Curtis, J. G. C., 383.—Doynes, W. T., 383.—Hawshaw, J., 380, 384.—May, C., 384.—Price, E., 381, 384.—Sanderson, C., 383.—Smith, —, 384.—Strapp, J., 382.—Valentine, J. S., 383.

Carr's railway crossing (Carr, H.), xiii. 487.

Chairs and fastenings. "On a new form of railway chairs and improved fastenings." By C. May, i. (1841) 83.—The fracture of chairs, 84.—Peculiar mode of casting, 84.—The mode of fastening the chairs to the sleepers, 84.—The disadvantages of spikes, 84.—"Keying up" the rails, 85.—Advantages of this form of chair and fastening, 85.

Discussion.—Cubitt, T., 85.—Hawkins, J. J., 86.—Mills, G., 86, 87.—Pim, J., 86.—Seaward, S., 86, 87.—Vignoles, C., 87.

Construction of. "On the construction of the permanent way of railways; with an account of the wrought-iron permanent way, laid down on the main line of the Midland railway." By W. H. Barlow, ix. 387.—On the maintenance of way, 388.—Tabular statement of the cost of maintenance, and the traffic, on the different lines worked by the North Midland, 389.—Progress of the derangement of the ordinary road, 389.—Inquiry into the duration of permanent way materials by the officers of the London and North Western railway, 390.—Description of the wrought-iron permanent way, 391.—Experiments for testing its elasticity and resistance to spreading, 392.—Experiment for testing the strength of the joint, 393.—Weight and cost of this kind of road, 393.—Part of Midland line laid with this rail, and Mr. P. W. Barlow's cast-iron sleeper, 394.—Appendix, table of experiments on the strength and deflection of railway bars,

PERMANENT WAY.

395.—Ditto, table of experiments on the strength of Mr. W. H. Barlow's rail, 399.—Ditto, experiments on joint casting, 400.—Ditto, ditto, Mr. P. W. Barlow's cast-iron sleepers, 401.

Discussion.—Barlow, P. W., 402, 404, 408.—Barlow, W. H., 401, 402, 407.—Brunel, I. K., 403, 404.—Errington, J. E., 407.—Glynn, J., 405.—Gregory, C. H., 405.—Hawkshaw, J., 402.—Locke, J., 405.—Moorsom, Capt. W. S., 408.

Construction of. "The construction and duration of the permanent way of railways in Europe, and the modifications most suitable to Egypt, India, &c." By W. B. Adams, xi. 244.—Principal requirements of permanent way, 244.—Flat tire-bar wrought-iron rail, 245.—Single T fish-bellied rail, 245.—Single T parallel rail, 246.—Double T parallel rail, 246.—Foot-rail, 246.—Bridge-rail, 246.—Split-rails, 247.—W. H. Barlow's saddle-back rail, 247, 263.—Transverse and longitudinal sleepers, 247.—Stone blocks, 247.—Rail without chairs, 249.—Comparative cost of transverse and longitudinal system of timber sleepers, 249.—Durability of ditto, 251.—Use of stone in lieu of ditto, 251.—Reynolds' inverted troughs of cast iron lined with wood, 252.—Greaves' surface-packed sleepers, 252.—Ditto, with Douglas' fish-joint chair, 253.—P. W. Barlow's cast-iron-sleeper, 254.—W. H. Barlow's cast-iron fish-joint sleeper, 255.—Samuel's cast-iron sleeper, 255.—Hoby's ditto, 255.—Imported French sleeper, 255.—Major Cochrane's cast-iron sleeper, 255.—Securing rails to chairs, 256.—Fastening chairs to sleepers, 256.—Ransome and May's compressed wedges and trenails, 256.—Simple mode of preparing oaken trenails, 258.—Securing ends of rails to each other, 258.—Method adopted for ditto on Blackwall railway, 258.—Operation of 'fishing,' 259.—Professor Gordon's horizontal half-lap joint, 260.—Fowler's joint chair, 261.—Samuel's fish chair, 262.—Various

PERMANENT WAY.

modes of 'fishing,' 263.—Varieties of rails proposed for obtaining stiffness, &c., 266.—Adhesion and friction, 267.—Provision for drainage, 268.—Street railways in United States, 269.—Permanent way on Continent, 269.—Durability of way, 270.—Permanent way in Egypt, India, &c., 270.

Discussion.—Adams, W. B., 273, 274, 280, 288.—Allport, J., 285.—Ashcroft, P., 276.—Barlow, P. W., 273, 278, 279, 292.—Bethell, J., 295.—Bidder, G. P., 292.—Bird, W., 277.—Brassey, T., 295.—Brunel, I. K., 274, 276, 286.—Errington, J. E., 291.—Hawkshaw, J., 283, 294.—Hoed, R. J., 282.—May, C., 284.—Moorsom, Capt. W. S., 280.—Phipps, G. H., 294.—Samuel, J., 277.—Simmons, Capt., 285, 295.—Stephenson, R., 296.—Wilson, W., 285.

Construction of. "The varieties of permanent way, practically used, or tried, on railways, up to the present period." By W. B. Adams, xvi. 226.—Mechanical principles essential to the efficient construction of, 226.—Rail must be deep enough to prevent deflection, and tread surface as close to the ballast as possible, to lessen the tendency to oscillation, 228.—Different forms of rails successively introduced, 228.—The edge-rail, 228.—The foot, or contractors' rail, and the bridge rail, 229.—Double T rail introduced by Mr. Locke, M.P., 229.—Various kinds of fastenings used with ditto, 229.—Disadvantages of the ordinary chair, 229.—Attempts to improve the joints of the rails, 230.—Fish-joint as specified and as used, 230.—Plans for preventing the nuts working loose, 231.—Lock-bolts for fishes, or brackets, or other rail fastenings, 232.—Recessed fish and bracket joints, 233.—Fowler's joint-chair, 233.—Samuel's fish-chair, 234.—P. W. Barlow's cast-iron chair in two parts, bolted beneath the rails, 234.—Day's cast-iron base plates, 235.—Mansell's pile-joint, 235.—McConochie's cast-iron wedge-chair, 235.—

PERMANENT WAY.

Joint and intermediate wrought-iron bracket for double T rails on cross-sleepers, 235.—Ditto, ditto, for foot-rails, 236.—Bracket chair of wrought iron in two parts, 238.—W. H. Barlow's double-wedged chair, 238.—Parsons' chair, wedge and end-grained cushions, 238.—Wright's vice-jaw chair, 239.—Barningham's joint, 239.—Plan of using wood brackets, or knees, to secure the rails to the sleepers, 239.—Burleigh's chair and key, 240.—Greaves' improvements in joints and fastenings, 241.—Joints and fastenings for foot and bridge rails, 242.—Truss-joint for ditto, 243.—Seaton's modification of the bridge-rail, 243.—Attempts to construct permanent way wholly of iron, 244.—Buck and Lacy's wrought-iron way, 244.—Reynolds' hog-trough metals, 245.—Greaves' spheroidal iron sleepers, 245.—W. H. Barlow's saddle-back rail, 246.—P. W. Barlow's cast-iron sleepers, 247.—W. H. Barlow's cast-iron fish-joint sleeper, as used on the Midland railway, 248.—Day's cast-iron base plates in two parts, 248.—Samuel's cast-iron sleepers, with the rails bedded in timber, 248.—Adams' girder-rail, 249.—Macdonnell's longitudinal iron bearing for bridge-rails, 249.—De Bergue's cast-iron sleepers for foot-rails, 250.—Adams' suspended girder-rail, 251.—Ordinary double T rail, suspended on angle brackets, 254.—Advantages proposed to be attained by the adoption of Adams' suspended girder-rail, 255.—Objections which have been made to the system, and reply to these criticisms, 256.—Adams' suspended girder-rail, with longitudinal timbers, 257.—Burleigh's cast-iron wedge sleeper, 257.—Spencer's corrugated-iron longitudinal sleepers, 257.

— "On some recent improvements in the permanent way of railways." By P. M. Parsons, xvi. 259.—Chief points aimed at, 259.—Use of wood as an elastic medium, tightening the fastenings by a hammer, and avoidance of

PERMANENT WAY.

- bolts and nuts, 259.—Dimensions of the joint-chairs, of the crescoted end-grain elm-blocks or cushions, and of the wrought-iron wedge fish, 260.—Ditto of the intermediate chairs, 262.—Means of producing the taper of the wrought-iron wedges, 263.—Peculiar advantages of the end-grain cushions, 263.—Difficulty of maintaining a good joint on ordinary systems, 265.
- Discussion.—Adams, W. B., 288.—Arthur, J. K., 278.—Barlow, P. W., 269, 284.—Barlow, W. H., 276.—Bidder, G. P., 287.—Bruff, P., 281.—Burleigh, B., 274.—Carr, H., 294.—Crampton, T. R., 295.—Errington, J. E., 277.—Greaves, H., 292.—Hawshaw, J., 283.—Hemans, G. W., 271.—Locke, J., 293.—May, C., 279, 287.—Parsons, P. M., 266.—Perring, J. S., 296.—Pole, W., 285.—Richardson, R., 278.—Sowerby, W., 285.
- Double-headed rail, position of the neutral axis in (Vignoles, C.), i. (1841) 121.
- Dublin and Drogheda railway. "Description of the rails, sleepers, and fastenings on the Dublin and Drogheda railway." By G. W. Hemans, v. 233.—Their advantages, 235.—Description of the machine employed for cutting the beds in which the rails lie on the sleepers, 236.—Cost of preparing the sleepers by this plan, 237.—Details of the cost of the rails, sleepers, and fastenings, 238.—Ditto per mile for a double line, 239.
- Discussion.—Bidder, G. P., 244.—Fox, Sir C., 242.—Harris, J., 242.—Hawshaw, J., 244.—Hemans, G. W., 242.—May, C., 239, 241.—Moorsom, Capt. W. S., 241.—Pasley, Lieut.-Gen. Sir C. W., 240.—Statham, T. H., 241.—Thomson, J. G., 242, 245.—Vignoles, C., 245.
- Hurry's railway crossing (Hurry, H. C.), xvi. 298.
- Inverted T rail. "On a peculiar form of rail, and the construction of railways in America and Germany." By H. Koehler, i. (1837) 25.
- Iron. "On the construction of railways

PERMANENT WAY.

- of continuous bearing." By J. Reynolds, i. (1837) 22.
- "On the results of trials of varieties of iron permanent way." By F. Fox, xx. 259.—Cost of renewal, owing to decay of ordinary way, of great importance, 259.—The longitudinal timber, or 'Brunel' way, 260.—The Macdonnell way, consisting of a longitudinal rolled-iron rail-bearer, as laid on the Bristol and Exeter railway in 1853, with the cost, 261.—Modifications of ditto, laid in 1857, with the cost, 263.—Ditto ditto, with a flat T-section bearer, laid in 1859, and the cost, 265.—Experiments to test the comparative strength of different sections of bearer, of rail and bearer combined as laid, and of the rail and bearer joints, with and without joint-plates, 267.—Result of ditto the adoption of a stronger section of bearer, in 1860, and the cost, 267.—The Macdonnell way on the Bridport railway, 269.—Cast-iron sleeper way of Mr. De Bugeue, 270.—Continuous stone way, 271.—Merits and defects of the continuous rolled-iron permanent way, 272.—Table of experiments on the vertical stiffness of rails, and rolled rail-bearers of different sections and combinations, 274.
- Discussion.—Barlow, W. H., 282, 283.—Berkley, G., 285.—Bidder, G. P., 289.—Bruff, P., 283.—Burleigh, B., 283.—Dockray, R. B., 280.—Fowler, J., 276.—Fox, F., 275, 286.—Gregory, C. H., 277.—Harrison, T. E., 279.—Hawshaw, J., 275.—Stephenson, G. R., 286.—Strapp, J., 282.—Vignoles, C., 282, 283.—Woodhouse, T. J., 277.
- Madras railway. "On the permanent way of the Madras railway." By B. M'Master, xviii. 417.—Leading features in the construction of railways in India, 417.—Description of the permanent way, and cost per mile of the materials delivered in Madras, 417.—As to a supply of iron from local sources for Indian railways, 418.—Variety of hard and durable woods fit for sleepers found in the forests

PERMANENT WAY.

and jungles, 419.—Creosoted fir-sleepers sent out from England, 419.—Statement showing the cost of creosoting four different kinds of native woods on the East Indian railway, 419.—Sleepers Kyanized, experimentally, with corrosive sublimate, on the Madras railway, 420.—Granite and laterite blocks used on ditto, 420.—English elm keys and oak trenails attacked by a species of beetle, 421.—Natives employed in laying the road, 421.—Staff engaged for the maintenance of the way and works, 421.—Damage from floods, 422.—Cost of maintenance, 422.—Discussion.—Abernethy, J., 488.—Adams, W. B., 441.—Bethell, J., 429, 485.—Bidder, G. P., 433, 434.—Blyth, E., 486.—Bruce, G. B., 423.—Brunlees, J., 435.—Greaves, H., 435.—Gregory, O. H., 425.—Harrison, T. E., 488.—Hawkshaw, J., 423, 432.—Locke, J., 443.—Maudslay, H., 438.—Moorsom, Capt. W. S., 439.—Parsons, P. M., 424.—Ransome, A., 424.—Rawlinson, R., 437.—Bendel, A. M., 437.—Samuel, J., 426.—Scott, M., 437.—Sinclair, R., 426, 433, 434.—Stevenson, D., 436.—Valentine, J. S., 424.

Philadelphia and Reading railway, U.S. "Account of the method employed in constructing the permanent way of the Philadelphia and Reading railway, U.S., with a description of a wrought-iron joint chair and fastening for the rails, as employed on the Baltimore and Susquehanna and other railways in the United States." By W. E. Newton, vi. 59.—Main objections urged by Mr. Heron against the usual methods of constructing the permanent way, 59.—Description of the 'trellis railway,' 60.—Mode of preparing the ground for reception of ditto, 60.—Description of a new double scarf, 61.—Mode of bolting the iron rails to trellis framing, 61.—Description of wrought-iron joint chairs, 62.—Ditto of several modifications of the above system, 65.—Appendix, containing estimates of the ordinary trellis railway structure, 70.—Ditto, of

PERMANENT WAY.

the timber-pinned trellis railway structure, 72.—Ditto, of the trellis railway, when laid with rolled-iron edge-rails, 73.—Ditto, of the primitive, the diamond, and the iron trellis railway structures, 74.—Ditto laid in asphaltic mastic, or cement of Seyssel, 75.

Discussion.—Barlow, P. W., 80.—Bidder, G. P., 79.—Brunel, I. K., 79.—Cubitt, Sir W., 80.—Mitchell, W., 79.—Newton, W. E., 76, 80.

Ransome and Biddell's solid chilled crossing, xvi. 299.

Riveted joints. "Description of the permanent way of the Lancashire and Yorkshira, the Manchester and Southport, and the Sheffield, Barnsley, and Wakefield railways." By J. Hawkshaw, viii. 26.

Discussion.—Barlow, P. W., 263.—Bidder, G. P., 269.—Brunel, I. K., 266, 268.—Gordon, A., 269.—Harding, W., 270.—Hawkshaw, J., 262, 268, 272.—Hodgkinson, E., 271.—Moorsom, Capt. W. S., 269, 271.—Pasley, Lieut.-Gen. Sir C. W., 271.—Pim, J., 269.—Samuel, J., 263.—Statham, T. H., 271.—Whishaw, F., 271.

Running gauge. "Description of a running gauge for ascertaining the parallelism of a railway." By E. Cowper, i. (1840) 30.

South Eastern railway. "Description of the permanent way of the South Eastern railway." By J. Pope, ii. (1842) 72.

Discussion.—Colthurst, J., 79.—Cubitt, Sir W., 75, 78, 79.—Cubitt, W., 79.—Horne, J., 79.—Lynde, J. G., 79.—Macneill, Sir J., 78.—May, C., 74, 77, 79.—Seaward, S., 79.—Walker, J., 78, 79.

Stone sleepers, M. D'Harcourt's artificial granite for, (Bastrick, J. U.), i. (1839) 59.

Switches and crossings. "On the construction of railway switches and crossings." By B. Burleigh, xiv. 419.—Fox's switch, 419.—Switches used on Great Western railway, 419.—Wild's switch, 420.—Crossings used on Great Western railway, 420.—Parsons' crossings, 420.—Baynes' switch, 421.—

PERRING.

Carr's crossing; 421.—Defects of different switches and crossings, 421.—Burleigh's single switch, 425.—Burleigh's acute crossing, 427.—Extract from letter by Mr. R. Stephenson, dated 7th July, 1847, on switches and crossings, 429.—Cost of repairs of switches and crossings on Great Northern railway, 430.

Discussion.—Bidder, G. P., 437.—Burleigh, B., 431, 433, 435, 436.—Carr, H., 432, 440.—Cubitt, J., 433.—Hawkshaw, J., 435.—May, C., 436.—Nixon, C., 433, 436.—Pole, W., 437.—Sanderson, C., 435.—Simpson, J., 442.—Stephenson, R., 434, 435, 436.

Wrought-iron key. "Remarks on the different methods of fastening railway bars in their chairs; and a description of a new hollow wrought-iron key." By W. H. Barlow, iv. 49.—The introduction and use of wooden keys, 49.—Disadvantage attending ditto, 50.—Estimated cost of renewal, 50.—Duty of the joint-key, and consequences of any imperfection, 51.—Hollow wrought-iron key proposed to remedy defects, 52.—Construction, 53.—Details of some experiments to ascertain the relative hold, or bite, of wooden and wrought-iron keys, 53.—Results, 54.—Further experiments as to their relative merits for joint-keys, 54.—Introduction of the hollow iron keys on several lines, 56.

Discussion.—Barlow, W. H., 56, 57.—Braithwaite, F., 56.—Cubitt, Sir W., 57.—Farey, J., 58.—Giles, F., 56.—Moorsom, Capt. W. S., 57.—Palmer, G. H., 56.—Smith, T. M., 57.—Walker, J., 57.

Vide also RAILWAYS, and TIMBER.

PERRING, J. S. [Election, xiii. 64.]

Bricks. "Account of some Egyptian bricks from the pyramids of Dashoor," ii. (1843) 169.

Permanent way of the East Lancashire railway, xvi. 296.

Railway breaks, particularly Mr. Newall's combination of breaks, and applications of the same principle, xvii. 161.—Ex-

PHIPPS.

periments to show the distance at which trains could be stopped, 164.

Pirro, Sir S. M., Bart. [Election, i. (1839) 44; Member of Council, v. 142.]

Agriculture. Nuisances likely to arise from spreading liquid manure over land near towns, vii. 94.

Steam boilers, incrustation of, v. 206.

Timber, use of creosoted, at Lowestoft harbour, ix. 48, 53.

PETRIE, —.

Electro-magnetism as a motive power, particularly the action of the permanent magnet, and the comparative value of the forces produced from zinc and from carbon, xvi. 412.

'Petuntse,' used as porcelain glaze, ii. (1843) 154.

Pharmacopœias of different parts of Europe, and even of the British islands, diversity in the, advanced as a reason for uniformity in weights and measures, xiii. 287.

'Philadelphia' American engine, description of the, on the Birmingham and Gloucester railway (Bishopp, G. D.), ii. (1843) 99.

PHILLIPS, John. [Election, vi. 297.]

Drainage of towns. Extract from a letter from, as to drainage of Rugby (Doulton, F.), xii. 62.

River Thames, experiments on the flux and reflux of the tide in the, xiii. 94.

PHILLIPS, Joseph. [Telford medal, xv. 81, 104; election, xix. 461.]

Roofs. "Description of the iron roof, in one span, over the joint railway station, New-street, Birmingham," xiv. 251.

PHILLIPS, R.

Iron ores of Turkey, iii. 245.

Stone, artificial, with a silica base, experiments upon the chemical nature of, vii. 68.

PHIPPS, G. H. [Election, i. (1840) 50.]

Beams. Position of the neutral axis in cast-iron beams, xvi. 80.

Bridges. State of the Menai suspension bridge after the storm of 1839, iv. 295.—Causes of failure of bridges and viaducts, and mode of building the piers, x. 235.

Girders. Direction of strains in sides of girders, xiv. 465, 474.

PHOTOGRAPHY.

Locomotive boilers, perfect combustion of fuel in, xii. 425.

Locomotive engines. The design of the 'Planet' locomotive engine, xvi. 24.

Metals, 'fatigue' of, xiii. 47.

Permanent way. No perceptible effect of contraction, or expansion in long lengths of rails, xi. 294.

Railway cuttings and slips, iii. 147, 169.

Telegraph cables. Difficulties which may be experienced in paying out telegraph cables in great depths, xvi. 224.

Water, flow of. Experiments on the flow of water through pipes of Edinburgh waterworks, xiv. 301.—Friction in pipes, compared with 'skin-resistance' in vessels, 302.—Resistance and friction in flow of water through pipes, 306.

Water, resistances to bodies moving in. Effect of the friction of the immersed surfaces upon the speed of vessels, xvi. 337.—Importance of arriving at the true resistance of vessels moving through the water at different speeds, 337.—Friction of water in pipes and on the outside of a ship, 360.

PHOTOGRAPHY.

"Photography, as applicable to engineering." By A. Gordon, i. (1840) 57.—On photography, 58.—On the daguerreotype, 58.

Discussion.—Cooper, J., 59.—Cooper, J. T., 59.

PHOTOMETER.

"Description of a new universal photometer." By Dr. C. Schaffhaeuti, i. (1841) 191.—Construction of the instrument, 102.—Method of use, 102.

PLATING, M.

Electro-plating, vi. 355.

PICKERSGILL, W. C. [Election, i. (1841) 168; resignation, xiii. 134.]

PIEROY, B. [Election, xx. 191.]

PIERS.

Blackfriars landing pier. "An account of the Blackfriars landing pier." By F. Lawrence, ix. 144.—Site of, and approach to, the pier, 145.—Construction of ditto, 145.—Return of the

PIERS.

number of persons landing and embarking at this pier, with the revenue derived therefrom, 148.

Gravesend, cast-iron. "Account of the new cast-iron pier, at Milton-on-Thames, next Gravesend, in the county of Kent; with details of the mode of construction adopted in its erection." By J. B. Redman, iv. 222.—Gradual increase of Gravesend, 222.—Improvements made in the town quay and landing-place, under the Act of Parliament of 1818, 224.—First proposals for erecting a pier, and subsequent construction of Town pier, 224.—Notice of improvements made by the shareholders of the Terrace Gardens, 225.—Their proposals for a new pier, 226.—Act of Parliament granted, 227.—Works contracted for by Messrs. Fox, Henderson, and Co., 227.—Description and dimensions of new pier, 227.—Register of the tides, 229.—Description of temporary works, 230.—Ditto of the mode of founding the columns, 231.—Ditto of the superstructure, 237.—Ditto of the roof, 240.—Ditto of the lighthouse, 241.—Ditto of the gate-lodges, 241.—Appendix A, the statistics of steam traffic to Gravesend, 242.—Appendix B, the population return for Gravesend and Milton, 243.—Appendix C, experimental tests of the strength of the cast-iron girders, 244.—Appendix D, tabular abstract of the dimensions and weights of the principal parts, 245.

Discussion.—Braithwaite, F., 249.—Clark, W. T., 248.—Fairbairn, W., 247.—McClean, J. R., 247.—Redman, J. B., 246, 247, 248.—Rennie, Sir J., 248.—Simpson, J., 249.

Madras (Annual Report), xix. 147.

Southend, timber. "Description of the pier-head of the old Southend pier, and of the recent extension of the structure; with an inquiry into the nature and ravages of the 'Teredo navalis,' and the means hitherto adopted for preventing its attacks." By J. Paton, ix. 23.—The old pier-head, 23.—The

PILBROW.

extension of the pier, 25.—The new pier-head, 27.—The ravages of the 'Teredo navalis,' 27.—The 'Limnoria terebrans,' 28.—On the chief peculiarities of the 'Teredo navalis,' and the nature of its food, 30.—On its mode of operation, 32.—Plans for preventing its ravages by saturation with chemical solutions, 34.—Tenacity of life in cold-blooded animals, 36.—Mechanical means for the protection of timber from the marine worm, 36.—Appendix, on the anatomy and development of the 'teredo' and the 'Chelura terebrans,' 38.—Ditto, table of the dimensions of the cast and wrought iron work, and scantlings of the timber, used in the construction of the new pier-head and the extension of the pier at Southend, 38.

Discussion.—Bethell, J., 50, 52, 57.—Bidder, G. P., 56.—Buckland, Dr., 41, 47.—Edwards, G., 45.—Jackson, G. B. W., 45.—Manby, C., 40, 51.—Newton, W., 45.—Paton, J., 40.—Peto, Sir S. M., 48, 53.—Playfair, Dr. L., 46.—Reeve, L., 49.—Rendel, J. M., 53.—Shepherd, —, 50.—Warren, J. N., 52, 57.—Whishaw, F., 49.

Southport, iron. "Description of the pier at Southport, Lancashire." By H. Hooper, xx. 292.—Site, 292.—Details of the structure, 292.—Mode of sinking the iron piles, 294.—The lattice girders forming the superstructure, 295.—The handrail, 296.—Advantages claimed for this mode of construction, 296.—Cost of the works, 297.

Discussion.—Bidder, G. P., 299.—Bruce, G. B., 298.—Brunlees, J., 298.—Curtis, J. G. C., 298.—Giles, A., 298.—Hawshaw, J., 298.—Hooper, H., 299.—Vignoles, C., 298.

Vide also BREAKWATERS; HARBOURS; HARBOURS OF REFUGE, and LANDING STAGES.

PILBROW, J. [Election, xv. 456.]

Piles, and pile-driving, iii. 200; iv. 77; vi. 87; x., 221, *et seq.*; xviii. 504, *et seq.*

—, iron, proper quality of iron to be used for, iii. 88.

PLAYFAIR.

Piles, Mitchell's screw, and moorings, ii. (1842) 150; vii. 108.

PRM, Captain B. C. T., R.N. [Election, xx. 375.]

PRM, J. [Election, i. (1838) 17; resignation, xv. 85.]

Permanent way. Fastenings for railway chairs, i. (1841) 86.—Timber sleepers on the Dublin and Kingstown railway, viii. 269.

Railway, atmospheric, iv. 144, 149.

Roofs. Liverpool iron roof, ix. 213.

Ships and steam vessels. Application of the combined power of the screw and sails to trading vessels, iv. 177.

PINCHBACK, —. [Telford medal, i. (1839) 5.]

Pinkus' system of atmospheric railway, iii. 270.

Ripe, copper, partially filled with carbonaceous deposit from brewer's wort, ii. (1843) 170.

PIPER, T. [Election, ii. (1842) 122; Member of Council, viii. 44.]

PIPER, W. [Election, viii. 266; Member of Council, xv. 76.]

Fire-proof buildings, construction of, particularly of model fire-proof house erected on Putney Common, in 1776, by Mr. Hartley, and method described by Lord Mahon, in 1778, being the application of a kind of pugging, identical to the process now practised in Paris, viii. 151.—Accidents to which iron is subject from, and the forms which it assumes after, exposure in a fire, 152.

Pipes, conduits, and orifices, observations on the flow of water through, (Lealie, J.), xiv. 273.

—, stone, experiments on the strength of, by T. Telford, for the Glasgow water-works, ii. (1843) 136.

Piston, elastic metallic, Mather's, vii. 289.

Pitch lake of Trinidad, extract from MS. essay, by the Earl of Dundonald, on the, xi. 383.

PITTS, J. [Election, xvi. 371.]

Planing-machines, xvii. 17, 26. *Vide* also MACHINERY, and MACHINES.

Plastic clay, near London, considered, iii. 154.

PLAYFAIR, Dr. L.

PLEWS.

- Fuel. Discrepancy between theory and practice in the duty obtainable from 1 lb. of coal, xii. 429.
- Marine worms. Natural history and habits of boring animals, ix. 46.
- Water supply. Analyses of the water from Watford, and from the deep wells in the chalk basin under London, ix. 159.
- PLEWS, J. [Election, xv. 348.]
- PLEWS, J., Jun. [Election, xviii. 490.]
- PLOWDEN, Major J. C. [Election, x. 192.]
- PLUCKNETT, G. [Election, xi. 422.]
- PLUM, —.
- Drainage of towns, xii. 82.
- Plumbago, cast iron changed into, in the early engines in Cornwall, ii. (1842) 153. — Rapidly formed where high pressure steam was used, 153.
- , cast iron changed into, under water, iii. 86. *Vide also* IRON.
- Plunger, for force pumps, used at Marly in 1683, iii. 91.
- Plymouth breakwater, effect of hydrostatic pressure on, i. (1841) 115.
- , account of the original construction and present state of, (Stuart, W.), (1841) 160.
- , ii. (1842) 124; v. 89.
- Plymouth limestone, and method of blasting (Stuart, W.), i. (1838) 35.
- Pneumatic mode of bending mirrors (Namyth, J.), i. (1840) 31.
- Pneumatics of mines, on the, (Richardson, J.), xii. 272.
- POINCESTON, W. W. [Council premium, x. 66; election, xv. 281.]
- Air engines. "Description of Sir George Cayley's hot-air engine," ix. 194.
- Polarized light, pencil of, employed for ascertaining the position of the neutral axis of bodies, iii. 248.
- Polborro Royal Console mines, valves of pumps used at, ii. (1843) 195.
- Polders, drained by the canal of Katwyk, ii. (1842) 172. — In Rhynland, drained artificially, 173.
- , mode of gaining land from the sea by, and the art of building by fascine work as generally adopted in Holland, Germany, &c. (Jackson, G. B. W.), vi. 95; (Conrad, Chev.), 149. *

POLE.

- POLA, W. [Election, i. (1840) 45; Telford medal, iii. 6; Auditor, xi. 83; xii. 111; xvii. 68; xviii. 163.]
- Air engines. Utility of the 'regenerator' of the hot-air engine, xii. 594.
- Aqueducts. Maddaloni aqueduct for conveying water to the Royal Palace of Caserta, near Naples, xiv. 234.
- Barometer, experiment with a, constructed with a bent and flattened steel tube, on M. Bourdon's principle, xi. 22.
- Beams. Problem for determining the strength of a beam, ix. 257.
- Bells. Musical quality of the bells at the New Palace, Westminster, xix. 15.
- Boilers. Advantage of Cornish boiler, xv. 297. — Small number of accidents with high-pressure boilers in Cornwall, 297.
- Bridges. Experiments on three forms of wrought-iron bridges, xi. 236.
- Canals. General objects of the canal of Marseilles, and notice of the principal aqueducts and tunnels on the line, xiv. 202. — Quantities of water which the canal will deliver at different sections, 203, 233.
- Girders of the Torksey bridge, continuity of, across the two openings, ix. 258. — Formulae for calculating the line of deflexion of the girder, 259. — Points of 'contrary flexure,' and their effect, 259. — Analogy between the results of the mathematical investigation and the experimental inquiry, 261. — Investigation of general formulae applicable to the Torksey bridge, 261. — Application to ditto, 265. — Calculated deflexion of ditto, under the specified load, 266. — Table showing the comparative strength and deflexion of the continuous girder, and of an independent girder spanning one opening only, 267.
- Machinery, danger of using self-acting, xv. 297.
- Permanent way. Improvements in railway crossings, xiv. 437. — Permanent way of the East Indian and the Madras lines, xvi. 285.
- Railway breaks. Application of a con-

POLINI.

tinuous break on the North London railway, xix. 524.

Rainfall. Quantity of rain falling, in the same locality, at different levels, on the Malabar coast of India, vii. 281.

Steam engines. "An investigation of the comparative loss by friction, in beam and direct action steam-engines," ii. (1843) 69.—Remarks, 73.—Reply to the observations on his Paper on friction, 73.—Authorities quoted by him, 77.

— "On the pressure and density of steam, with a proposed new formula for the relation between them, applicable particularly to engines working with high-pressure steam expansively," ii. (1843) 209; vi. 350.

— Indicator diagram taken from a Cornish engine at the East London water-works, xii. 593.

Surveying instruments. "Description of the prismatic clinometer; a new pocket instrument for measuring vertical angles," xi. 23.

Polini's investigation of the question of the rotation of the earth, x. 321.

Poling-boards of the shield at the Thames tunnel, ii. (1843) 80.

POLLARD, W. B. [Election, xix. 489.]

POLLOCK, Lieutenant F., M.E. [Telford medal and premium, i. (1840) 8; election, v. 248; resignation, x. 72.]

Coffer-dams. "A description of the coffer-dam round the 13 and 14 feet piers of Westminster bridge," i. (1839) 66.

POLLOCK, G. K. [Election, iii. 101; resignation, x. 72.]

PONCELET, M.

Iron, wrought. Coefficients T_e and T_r designed by, to express the 'work done' by an extending or compressing force upon any elastic prismatic body, at the point where its elasticity becomes permanently impaired and its form distorted, and at the further point where rupture occurs (Mallet, R.), xviii. 298.

Water-wheels. Undershot water-wheel with curved floats (Gordon, Prof.), ii.

PORT OF LONDON.

(1842) 93.—Results of experiments on water-wheels (Rennie, G.), (1843) 64.

Poncelet and Lesbros' experiments on the discharge of water by rectangular orifices, x. 332.

PONSONBY, —.

Architectural decoration. 'Cannabic composition,' iii. 70.

Pont du Gard, description of the, or aqueduct of Nismes (Rennie, G.), xiv. 236.

Pont-y-tu-Prydd over the river Taaf, Glamorganshire (Smith, T. M.), i. (1838) 36; v. 474.

PONTIFEX, S. [Election, xviii. 72.]

Pontoon at New Holland, ix. 140.

Pontoons used for the landing platforms at Liverpool, v. 31.

POOLE, B. [Election, xi. 422; Telford medal, xii. 115; resignation, xv. 85.]

Decimal coinage, &c. Primary importance of the ton, in the series of weights, shown in his work on the 'Statistics of British Commerce' (Yates, J.), xiii. 296.

Railways. "The economy of railways as a means of transit, comprising the classification of the traffic, in relation to the most appropriate speeds for the conveyance of passengers and merchandize," xi. 450.—Remarks, 472.—Reduction in rates of carriage effected by railways, 464.

POOLE, J.

Safety-valve, parallel motion, xix. 52.

POOLE, M. [Resignation, ix. 97.]

POOLEY, H. [Election, x. 192.]

POPE, J. [Election, i. (1841) 87; memoir, viii. 72.]

Bridges. "Description of a bridge for a railway crossing above a turnpike road, where the depth between the soffit of the bridge and the surface of the rails is limited to twenty-one inches," i. (1841) 87.

Permanent way. "Description of the permanent way of the South Eastern railway," ii. (1842) 72.

Porcelain reflectors for lights, xv. 26.

Port of Ipswich, on the river Orwell, and the (Hurwood, G.), xx. 4.

— of London, description of, and of the

PORT TALBOT.

works at the London docks (Richardson, R.), ii. (1842) 59.

Port Talbot, Glamorganshire, description of the harbour of, (Palmer, H. R.), ii. (1842) 188.

PORTEOUS, R.

Signal whistle for railways, and for other purposes, iv. 150.

PORTER, J. F. [Election, ii. (1843) 134.]

PORTER, J. H. [Election, x. 57.]

Portland cement. *Vide* CEMENTS.

Porto-Nuovo, iron works at, in the East Indies, iii. 225.

Portpatrick, sea-wall at, vi. 129.

Portunna bridge, across the river Shannon (Rhodes, T.), iii. 99.

Postage Association, for obtaining a uniform rate for letters and parcels throughout the world, xiii. 289.

Postal facilities afforded by railways, xv. 133.—Extracts from second report of the Postmaster-General, 456.—Reply of Mr. R. Stephenson, M.P., President, to ditto, 470.

POTTER, E. [Election, xvii. 540.]

POTTER, J. [Memoir, xvii. 94.]

Pottery clays, composition and uses of, ii. (1843) 149.

Potts' pneumatic cylinders, for forming artificial foundations, as first applied to a bridge on the Chester and Holyhead railway, and subsequently at Rochester bridge, x. 319.—Process reversed at Rochester bridge, so as to give each pile the character of a diving-bell, 355.

POULTER, Captain.

Buoys, beacons, sea-lights, &c., and manner of mooring them, xv. 14.

Pound lock, first introduction of, on the Exeter canal, iv. 91, 111.

Power, cost of different means of producing, xvi. 413.

—, effective, (Parkes, J.), ii. (1842) 113.

POWER, J. W. [Election, i. (1840) 41; resignation, xii. 121.]

POWER, S. [Election, ix. 133.]

POYNTER, A.

Aqueduct, Ponte Maddalona, for conveying water to the Royal Palace of Caserta, near Naples, xiv. 234.

PRESENTS RECEIVED.

Roofs, covered with Lord Stanhope's composition, ii. (1843) 96.

Smoke, prevention of. Number of new chimney-shafts erected in the metropolitan districts from 1845 to 1853, xiii. 413.

PRENCE, W. H. [Election, xviii. 525.]

Telegraph cables. "On the maintenance and durability of submarine cables in shallow waters," xx. 26.—Remarks, 49.—Necessity of applying some exterior protecting coating to all cables, 49.—Question of the insulating media, 50.—Calculations of the reduced resistances, 60.—Channel Islands cable, its construction and route; the accidents that have happened to it, and the means taken to repair them, 91.—Failures and defects in the construction of submarine cables for shallow waters, 92.—Use of heavy, or of light cables, 93.—Decay of cables from corrosion, 93.—Different systems of testing cables, and the instruments employed, 94.—Comparative superiority of india-rubber and gutta-percha as insulating materials, 95.—Construction of deep-sea cables, 95.

Premium, Manby, resolution establishing a, xvii. 70.

—, Walker, cessation in the distribution of, and the cause, v. 2.—Premium fund, in future to be raised by the Council for the time being, 3.

Premiums awarded, i. (1837) 7; (1838) 8; (1839) 5, 81; (1840) 4; (1841) 6, 19; ii. (1842) 6, 17; (1843) 6, 17; iii. 6, 20; iv. 3, 14, 61; v. 2, 14, 160; vi. 1, 14, 57; vii. 2, 22, 74; viii. 5, 22; ix. 90, 95, 112; x. 59, 65, 104; xi. 87, 118; xii. 110, 115, 169; xiii. 123, 126, 162; xiv. 96, 104, 172; xv. 75, 104; xvi. 85, 92, 171; xvii. 68, 80, 108; xviii. 163, 174, 206; xix. 131, 155, 193; xx. 107, 121, 170.

PRENTICE, A. [Election, xii. 272.]

Presents received, i. (1837) 6, 11; (1838) 8, 13; (1839) 13, 21; (1840) 11, 22; (1841) 13, 32; ii. (1842) 35; (1843) 9, 40, 192, 200; iii. 9, 40; iv. 5, 32; v. 3, 129; vi. 3, 35; vii. 5, 47; viii. 35;

PRESSURE-GAUGE.

ix. 96, 122; x. 69, 113; xi. 90, 128; xii. 119, 181; xiii. 174; xiv. 106, 182, 273; xv. 83, 114; xvi. 96, 180; xvii. 84, 118; xviii. 181, 217; xix. 162, 203; xx. 127, 180.

Pressure-gauge, used at the Liverpool gas-works, for indicating small amounts of pressure, ii. (1843) 192.

PRESTON, R. B. [Election, xiv. 418; memoir, xx. 157.]

PRESTWICH, J., Jun.

Water supply. Definition of term 'water-bearing stratum,' xiv. 77.—Character of chalk under London, 77.—Effect of pumping on water-level, 77.—Depth at which water may be obtained in the chalk, 78.—Water-level in the wells in the chalk, 79.—Artesian well at Grenelle, 79, 91.—Kentish-town well, 89.—Chances of obtaining supplies of water from chalk, 90.—Experiments for ascertaining infiltration of rainfall, 90.—Artesian wells in tertiary sands below London, 91.

PRICE, E. [Election, xvi. 46.]

Permanent way, method of expediting the laying of the, when using Greaves' cast-iron spheroidal sleeper, as practised in Egypt, xvi. 381.—Ditto, when laying the Barlow rail in the Brazils, 384.

PRICE, H. H.

Cements, i. (1837) 19.

PRICE, J.

Shingle, movement of, in bay of Llandrillo, xi. 216.

PRICE, J. T. [Election, iv. 186; resignation, xii. 121.]

'Prideaux' perforated door, for admitting air into furnaces, to prevent the emission of smoke, xiii. 409.

'Princeton' steam frigate, iii. 83.

PRIOR, J. C. [Election, i. (1839) 54; memoir, ix. 104.]

Fuel. Straw coals, i. (1839) 67.

Prismatic clinometer, a new pocket instrument for measuring vertical angles (Pole, W.), xi. 23.

Projectiles. *Vide* ARTILLERY.

PRONY, M. DE.

Dynamometers. Reference to an experi-

PUBLIC WORKS IN BRAZIL.

ment with his brake-dynamometer (Bennie, G.), ii. (1842) 101, 102.

Propellers. *Vide* SCREW PROPELLER.

PROSSER, R.

Brickmaking and pottery. His system of moulding dry clay by compression (Farey, J.), ii. (1843) 147, 148; (Pellatt, A.), 149; (Blashfield, J. M.) 149, 152.

Protectors, Sir H. Davy's, for preventing the oxidation of copper sheathing, ii. (1842) 66.—Abandoned in 1828, 67.—Caused the formation of a substance which ignited spontaneously, 67.—Tried in the French and the United States navies, 67.

PROVIS, W. A. [Member of Council, i. (1837) 15; (1838) 20; (1839) 27.]

Bridges. "Observations on the effect of wind on the suspension bridge over the Menai Strait, more especially with reference to the injuries which its roadways sustained during the storm of January, 1839," i. (1841) 74.

Water, flow of. "Experiments on the flow of water through pipes of different lengths," i. (1838) 48.

Public works, as to, coming under the control and cognizance of the Government, vii. 30; ix. 181, *et seq.*; xiii. 115, *et seq.*—Evils attending the mode of granting concessions for public works in Portugal, and in some other continental countries, xviii. 18.

PUBLIC WORKS IN BRAZIL.

"On the means of communication in the empire of Brazil; chiefly in reference to the works of the Mangaratiba Serra road, and to those of the Mauá, the first Brazilian railway." By E. B. Webb, xix. 240.—Civilization of the country effected by Jesuit missionaries, 240.—Extent of coast, 240.—Internal lines of communication by bridle paths, 241.—Character of the Province of Rio de Janeiro, 241.—Paved descents of the 'Serra do Mar,' 241.—Carriage-road up the face of the Serra to Petropolis, 242.—The Mauá railway, 242.—Absence of any correct map, labour of making the survey,

PUBLIC WORKS IN INDIA.

and of taking the levels for the railway, 242.—Mode of prosecution of the works, particularly of the excavations, 243.—Slave-labour and its cost, 244.—Great inequality in the character of the timber, and its liability to decay, as instanced in the bridges on the line, and in the pier forming the southern terminus in the Bay of Rio, 244.—Advantages of the double-headed rail, 245.—Unhealthiness of the district through which the line was carried, and cost of the works, 246.—The Mangaratiba Serra road, 246.—Land traffic to and from the Port of Mangaratiba, 246.—Contract with the Government for the construction of a carriage-road up the Serra, 247.—Chinese labourers proved to be useless, 247.—Employment of Portuguese labourers, 247.—Character of the strata met with in cutting the road, 248.—Works executed in a number of small contracts, 249.—Supply of the necessaries of life to the men a serious consideration, 249.—Quality of the works, particularly of the masonry, and cost of a cut-stone bridge, 249.—Result of employing English workmen in a country like Brazil, 250.—Comparative scarcity of slaves, 250.—Dimensions and cost of the Mangaratiba road, 251.—Brazil possesses little internal water-communication, 251.—The railways now in progress, 252.—The supply of labour for public works and facilities for colonization should be considered together, 253.—Two methods of guarantee in operation for the railways, 253.—Brazil little known in England, 254.

Discussion.—Bidder, G. P., 255, 261.—Bruce, G. B., 258.—Brullees, J., 256.—Errington, J. E., 257.—Fowler, J., 259.—Hawkshaw, J., 258.—Hopkins, E., 256, 259.—Moorsom, Capt. W. S., 255.—Webb, E. B., 255, 256, 260.

PUBLIC WORKS IN INDIA.

"On public works in the Bengal Presidency." By Maj.-Gen. B. Tremenhare, xvii. 483.—Early introduction of,

PUBLIC WORKS IN INDIA.

into that country, and subsequent development, 483.—Ancient bridge, serving also as an aqueduct, on the river Cauvery, at Seringapatam, 483.—Condition of the public roads during the Mahomedan period, 484.—The caravanserais, 484.—Water-tanks for the purposes of irrigation, 485.—The Emperor Feroze's canal, 485.—New city of Delhi, founded by, and other works erected by, Shah Jehan, 486.—State of the country from 1746 to 1823, and in 1827, 486.—Physical features of the Bengal Presidency, 487.—Embankments, or bunds, for confining the waters of the Ganges within certain definite limits, 488.—Physical condition of the higher provinces, 489.—Restoration of Feroze Shah's canal, 489.—Permanent dam of masonry on this canal, 490.—Main channel of the canal near Delhi, 491.—The Negumbode aqueduct, 491.—Reopening of the Eastern Jumna canal, and works of improvement on it, 492.—Expenditure on, and revenue realized by, the Western and Eastern Jumna canals, up to May, 1852, 492.—The Ganges canal, course of the line, and dimensions, 492.—Passage provided for the Rutmoo torrent, 493.—Ditto for the Rampoor and Puttree torrents, 494.—Aqueduct across the Solani valley, 494.—Side channel of the river Ganges, flowing beneath the town of Hurdwar, 494.—Canal irrigation, and increase of produce by, 495.—The Boorkee College of Civil Engineering, 495.—Artificial irrigation in the province of Rohilkund, 496.—Facilities for irrigation in the Pillibheet, Bareilly, and Shahjehanpoor districts, 496.—Watercourses for irrigation in the valley of Deyrah, 496.—Works of irrigation in the Agra district and in Ajmere, 497.—New canal for the Punjab, 497.—Advantages resulting from artificial irrigation, 498.—Facilities for inland river navigation in the northern portion of Hindostan, 498.—Necessity for providing for the shallowness of the navigable stream during the dry season of the year, 499.—Efforts to deepen the

PUBLIC WORKS IN INDIA.

main channel of the Ganges, 500.—Obstructions in the river Jumna, between Agra and Allahabad, 500.—The Indus peculiarly adapted to steam navigation, 501.—Little demand for works on the coast of India, 501.—Neglect of the public roads by the English rulers of Hindostan, 501.—The Grand Trunk road, its dimensions, the materials employed, service for effecting repairs, original cost, and halting-places or encamping grounds on the line of, 501.—Causes of the delay in completing the bridges over the rivers on the line of ditto, 503.—Details of the service for the construction and repair of ditto, 504.—Extension of ditto from Delhi to Kurnaul, and thence to Lahore and Peshawur, 504.—The Great Deccan road, 505.—Road from Agra to Bombay, 505.—Construction and improvement of district roads, particularly in the districts of Azimgurh and Bareilly, 505.—The local road-funds should be applied, hereafter, in furthering the multiplication of railways, rather than common roads, 506.—Necessity for agricultural improvements, 507.—Course of the main lines of railway communication now constructing in India, 507.—Necessity for branch lines as tributaries, 508.—List of railways guaranteed by the Government of India, 508.—Cost of the portions of the East Indian and the Madras lines already executed, 508.—Character of the works on the Indian railways, 509.—Tariff of charges, receipts, and number of passengers on the opened portion of the East Indian railway, 509.—The use of coke for the locomotives superseded by native coal, 510.—The European element requires to be fostered and increased in India, 510.—Sir H. Lawrence's asylum at Kussowlee, 511.—Waste of European life, from natural and other causes, 511.—Proposed asylum at Darjeeling, for the children of soldiers, 512.—Establishment of electric telegraphic communication, 512.

PUMP VALVES.

Discussion.—Boileau, Gen., 530.—Bruce, G. B., 529.—Conybeare, H., 514.—Greaves, C., 522.—Hawthshaw, J., 528.—Henderson, Capt., 531.—Locke, J., 537.—Sibley, G., 524.—Tremenheere, Maj.-Gen., 514, 537.

PUCKLE, Captain J. [Election, xx. 106.]

Puddled steel, xviii. 337, *et seq.*

Puddling. *Vide* IRON.

Pulteney town and harbour, description of, (Bremner, J.), iii. 115.

PUMP VALVES.

"Description of annular valves used for pumps for water-works, &c." By R. Hoeking, ii. (1843) 195.—Concentric rings arranged pyramidally, 195.—Concussion and wear and tear avoided, 195.—Where used, 195.

"On the construction of valves used in pumps for raising water." By S. C. Homersham, ii. (1843) 195.—Description of the defects and the modifications of common leather flap valves, 195.—Concussion from the closing of the pump valves at the East London water-works, 196.—Introduction and durability of Harvey and West's improved valve, 196, 198.—Pressure required to open the valves, 196.—Improved conical concentric ring valve suggested by J. Simpson, 196.—Advantages of ditto, 196.—Adopted at Lambeth and Chelsea water-works, 196, 197.—Wood seatings adopted on account of the galvanic action between the metal faces, 196, 197.—Rule for finding the proper weight of pump valves in proportion to the height of the column of water, 197.—Large areas for the water passages advocated, 197.—Velocity of water up the suction pipe, 197.—Lift of the valves, 197.—Valves for short lifts, 197.

Discussion.—Glynn, J., 199.—Parkes, J., 199.—Simpson, J., 199.—Taylor, J., 198.—Wicksteed, T., 198.

"On the concussion of pump valves." By Sir W. G. Armstrong, xii. 450.—Valve made of annular form, to allow the water to escape on all sides, 450.

PUMP VALVES.

—Spiral spring applied to press upon each valve, 450.—Annular opening extended, to diminish the bearing surfaces, 453.—Annular valve abandoned in favour of the single-beat valve, 453.

Discussion.—Armstrong, Sir W. G., 456.—Brockedon, W., 458.—Brunel, I. K., 457.—Cowper, E. A., 456.—Crampton, T. R., 457.—Hawksley, T., 456, 457.—Humphrys, E., 457.—Maudslay, H., 456.—Rendel, J. M., 459.—Russell, J. S., 456, 457.—Thomson, D., 456.

Pump valves, description of the principal, used by mining engineers, iii. 88, *et seq.*

Pumping, cost of, at the different stations of the Liverpool water-works, xii. 493.

Pumping engines, iii. 91.

Pumping-machinery used in the construction of the Royal Border bridge, over the river Tweed, on the York, Newcastle, and Berwick railway, x. 225.

Pumps worked by water-wheels at Wheals Betsy and Friendship, ii. (1842) 97.—In Cornish mines, friction of, diminished, 121.—In the northern coal-pits, described, 171.—Power required to

PYROMETER.

work those at Messrs. Truman and Co.'s brewery, ii. (1843) 79.—At the Glasgow water-works, 137, 138. —Length of suction pipes, 138.

Punching iron and copper plates, experiments to determine the force necessary for, (Colthurst, J.), i. (1841) 60.

—, Larivière's system for simultaneously punching a number of holes, xiii. 266.

—, shearing, riveting, and forging machinery, on, (Sawyer, T. S.), xvii. 173.

PURDON, W. [Election, xviii. 72.]

PURDON, W. H. [Election, xix. 130.]

Purkis' method of propulsion, xiii. 378.

PUSKER, E. [Election, xix. 263.]

PYM, J.

Railway inclines. Dalkey incline plane, x. 254.

Pyramids of Daahoor, Egypt, bricks from, (Perring, J. S.), ii. (1843) 152, 169.

—, description of, ii. (1843) 170.—Date of construction, 170.

Pyrites, decomposition of, cause of slips in railway cuttings, iii. 150.

Pyrometer, Houldsworth's, for indicating the rise, or fall, of the temperature within the working part of a flue, xiii. 402.

Q.

QUARM.

QUARM, T.

Balls at the New Palace, Westminster,
xix. 13, 14.

QUETELET, M.

QUICK.

Decimal coinage, &c. Adoption of the
French metrical system in Belgium
(Yates, J.), xiii. 294.

QUICK, J. [Election, xiii. 475.]

R.

RADFORD.

- RADFORD, W. [Election, i. (1841) 73; resignation, xii. 121.]
- RADFORD, W. (London). [Election, viii. 273; memoir, xiv. 136.]
- Bridges. Insistent pontoon bridge at the Dublin terminus of the Midland Great Western railway of Ireland, ix. 352.
- Coffer-dams, particularly those at Blackfriars bridge, viii. 303.
- Engines. Standard for pumping engines, x. 311.
- Foundations of bridges over the river Don and canal, at Sprotbro', x. 306.
- Mortar making, particularly that used at the King's Cross station of the Great Northern railway, x. 234. — Weight which good rubble will bear, 240.
- Paving of Blackfriars bridge, ix. 223.
- Rivers and estuaries. Longitudinal section of the tidal flow in a river, xii. 21.
- RADFORD, W. (Manchester). [Election, viii. 206.]
- RADSTOCK, Lord.
- Caisson closing the entrance into the basin at Woolwich dockyard, xiii. 458.
- Rail, on a peculiar form of, and on the construction of railways in America and Germany (Koehler, H.), i. (1837) 25.
- Rails, trough-shaped bearing for, i. (1837) 23. — Method of laying on the Birmingham and Gloucester railway, ii. (1842) 54. — Ditto on the South Eastern railway, 73, 77. — Inclination of, given in the chairs, insures accuracy, 77. — Rails used on the Amsterdam railway, iii. 178. — Method of laying ditto, 178. — Rails and rolled rail-bearers, of different sections and combinations, table of experiments on the vertical stiffness of, xx. 274. *Vide also* PERMANENT WAY.
- Railway and canal companies, advantages which would result from co-operation between, especially in and near to the metropolis, xvii. 400.

RAILWAY, ATMOSPHERIC.

RAILWAY ACCIDENTS.

"Railway accidents, their cause and means of prevention; detailing particularly the various contrivances which are in use, and have been proposed." By Capt. M. Huish, xi. 434. — Railway travelling contrasted with other modes of inland communication, 435. — Casualties at sea, and in mining, 435. — A good permanent way, the basis of safety in railway travelling, 436. — Self-acting switches, 438. — The locomotive engine, 439. — Analysis of 1,000 cases of engine failures and defects, occurring on the London and North Western and subsidiary railways, 440. — Carriage stock of railway companies, 441. — Occurrence of fire in a passenger-train, 441. — Ditto in merchandize-trains, 444. — Accidents from inattention to signals, 444. — Question of regularity in the times of the trains, 446. — Effect of electric telegraph in working the London and North Western railway during the Great Exhibition, 447. — Minor causes of accidents on railways, 448. — Railway servants, 449.

RAILWAY, ATMOSPHERIC.

"The atmospheric railway." By Jacob Samuda, iii. 256. — Description of the apparatus, 257. — Early inventors of, 259. — Medhurst's system, 259. — Clegg and Samuda's system, 264. — Tallow valve, 264. — Power employed, 265. — Leakage, 265. — Gradient of line, 266. — Comparative expense of haulage, 267. — Application to the Dalkey line, 268.

Discussion. — Bergin, —, 275. — Braithwaite, F., 282, 283. — Clegg, S., 271. — Cowper, E., 272. — Farey, J., 277, 283. — Gibbons, B., 272, 274. — Homersham, S. C., 282. — Horna, J., 274. — Pasley, Lieut.-Gen. Sir C. W., 274. — Newton, W., 269. — Samuda, Jacob, 269, 271

RAILWAY, ATMOSPHERIC.

274, 276, 282.—Samuda, J. D'A., 272.
—Slate, A., 277.

"On the comparative advantages of the atmospheric railway system." By P. W. Barlow, iv. 114.—Objections to the system, 115.—Comparative cost of haulage by the stationary and locomotive systems considered, 117.—Remarks on the application of the system to inclined planes, 117.—Estimated cost of applying it to the London and Birmingham railway, 118.—Results of the investigations, 119.—Appendix containing details of some experiments made on the Tyler Hill inclined plane of the Canterbury and Whitstable railway, and observations thereon, showing the relative amount of lost power by the rope traction, as compared with that by the atmospheric system, on the Dalkey inclined plane, 122.

Discussion.—Barlow, P. W., 144, 145, 146.—Brunel, I. K., 146, 150.—Cubitt, Sir W., 147, 149.—Gregory, C. H., 145.—Pim, J., 144, 149.—Russell, J. S., 147, 149.—Samuda, J. D'A., 143, 149.

"The peculiar features of the atmospheric railway system." By G. Berkley, iv. 251.—Remarks as to working the traffic, 252.—Ditto as to the arrangements at level crossings, 253.—Comparison of the speed, with that attained by locomotives, 254.—Ditto as to its supposed increased safety for single lines, 254.—Whether it presents advantages in overcoming worse gradients than exist on locomotive lines, 256.—Mr. R. Stephenson's estimate of the probable cost of working the London and Birmingham railway by this system, 258.—Whether it possesses economy in the maintenance of the permanent way, 259.—Reasons for the permanent way of the Dalkey incline being maintained at a cheaper rate than other parts of the Dublin and Kingstown railway, 260.

Discussion.—Barlow, P. W., 274, 287.—Berkley, G., 272.—Bidder, G. P., 264, 286.—Braithwaite, F., 279.—Fairbairn, W., 279.—Gregory, C. H., 275.—Hawkshaw, J., 287.—Hawksley, T.,

RAILWAY AXLES.

281.—Locke, J., 278.—Lowe, G., 281.—Mallet, R., 290.—May, C., 278, 285.—Nicholson, R., 286.—Rendel, J. M., 290.—Russell, J. S., 264, 277, 285.—Samuda, J. D'A., 266, 275, 288.—Stephenson, R., 261, 269.—Taylor, J., 280.—Vignoles, C., 272, 278.—Walker, J., 289.—Wood, N., 280, 286.

Atmospheric system as proposed by Valance (Rennie, Sir J.), v. 80.—Ditto by Medhurst, 80.—Ditto by Clegg and Samuda, 80.—Notice of its application to the Dublin and Kingstown railway, 80.—Ditto to the Croydon railway, 80.—As proposed by Pilbrow, 81.—Ditto by Hallette, 81.—Law affecting leakage (Froude, W.), vi. 373.—Experiments upon the South Devon railway, 385.—Proposed series of experiments upon the atmospheric railway (Annual Report) vii. 16.—Account of the working of the atmospheric system on an incline on the St. Germain railway (Drysdale, O. R.), xv. 361.

RAILWAY AXLES.

Fracture of, in consequence of the changes induced in the internal structure of the iron (Hood, C.), ii. (1842) 180.—Rapid rotation of railway axles induces magnetism, 180.—Samples of broken ones, 181.—Fractured axles usually exhibit a large crystallized texture (Moreland, R.), 181; (Woods, E.), 181; (Hood, C.), 181, 182; (York, J. O.), 181, 182.—Hollow axles, 183.

"Account of a series of experiments on the comparative strength of solid and hollow axles." By J. O. York, ii. (1843) 89.—Causes of fracture, 89.—Effects of concussion and vibration, 89.—Fracture generally occurs in the journal, 89.—Effects of a twisting strain, 89.—Causes of hollow axles resisting strains better than solid ones, 89.—Experiments on rigidity and on elasticity, 90.

Discussion.—Fox, Sir O., 94.—Geach, O., 91.—Gravatt, W., 93.—Newton, W., 94.—Pasley, Lieut.-Gen. Sir O. W., 92.—Taylor, J., 93.—Walker, J., 94.—York, J. O., 91, 28.

RAILWAY BARS.

"On the causes of the unexpected breakage of the journals of railway axles, and on the means of preventing such accidents by observing the law of continuity in their construction." By W. J. M. Rankine, ii. (1843) 105.—Usual reasons for their fracture, 105.—Gradual deterioration of axles while in use, 106.—Fracture commencing all round the journal near the neck, and increasing gradually, 106.—Fracture convex, 106.—Fracture owing to the form of the journal and inequality of elasticity, 106.—A change of form of the journals proposed, 106.—Effect of vibration considered, 107.

Discussion.—Parkes, J., 107.—York, J. O., 107.

"Description of an improved form of the journals of the axles for railways." By Capt. E. B. Handcock, ii. (1843) 166.—Disadvantages of common axles, 166.—Advantages of the use of moveable cones instead of fixed brasses, 166.—Consumption of oil with improved axles, 166, 167.

Discussion.—Fairbairn, W., 167.—Field, J., 167.—Handcock, Capt., 166, 167.—Pasley, Lieut.-Gen. Sir C. W., 167.

"Account of a series of experiments on the comparative strength of solid and hollow axles." By C. Geach, iii. 201.

"On the causes of fracture of the axles of railway carriages." By J. Glynn, iii. 202.

Results of some experiments on the strength of railway axles (Thornycroft, G. B.), ix. 298.—Remarks, 300.—Causes of the unexpected breakage of the journals of, xiii. 467, *et seq.*; xix. 16.

Vide also IRON; and METALS, Fatigue, and fracture of.

Railway bars, description of a sawing machine for cutting, (Glynn, G.), i. (1839) 51.

—, corrosion of, ii. (1843) 177.

—, flexure of, xvi. 384.

Railway blocks, M. D'Harcourt's artificial granite for, i. (1839) 59.

RAILWAY BREAKS.

RAILWAY BREAKS.

Breaks used on the locomotive engines on the Lickey incline (McConnell, J. E.), ii. (1843) 104.—*Ditto* on the London and Blackwall railway (Bidder, G. P.), v. 158.

"On railway breaks." By E. Guérin, xvii. 153.—Break now generally employed identical with that used for carriages on common roads, 153.—The slide break, 153.—Various plans for applying the friction to prevent damage to the tire, 154.—Mr. Heath's plan for working, simultaneously, breaks fixed on several vehicles of the same train, 154.—Mr. Newall's simultaneous break, and experiments on the East Lancashire railway to test its efficiency, 155.—Manner of working breaks, and source of the power for acting on them, 156.—Employment of the steam-pressure from the boiler on the Namur and Liege railway, 156.—Mr. Miles' arrangement for acting on the breaks, simultaneously, by hydrostatic pressure, 156.—Old arrangement of hand-breaks, on single vehicles, radically defective, 156.—Mr. Nasmyth's proposal to take advantage of the pressure exerted on the buffers, when the engine-power is stopped, 157.—Mr. George Stephenson's self-acting break, 157.—Difficulty of carrying the principle of the buffer-break into practice, 158.—Adaptation of centrifugal force to render Mr. Stephenson's break automatic, 158.—Contrivance for backing and shunting, 159.

Discussion.—Adams, W. B., 165.—Beattie, J. H., 168.—Errington, J. E., 171.—Guérin, M., 169.—Harrison, T. E., 170.—Hawkshaw, J., 169.—Hemans, G. W., 169.—Locke, J., 171.—Newall, J., 168.—Perring, J. S., 161.—Tyler, Capt., 170.

Apparatus for working (Hall, W.), xviii. 70.

"On the efficiency of various kinds of railway breaks; with experimental researches on their retarding powers." By W. Fairbairn, xix. 490.—Colonel

RAILWAY BREAKS.

Yolland's report to the Board of Trade relative to the steam-break of Mr. McConnell, the continuous break of Mr. Fay, the continuous and self-acting break of Mr. Newall, and the self-acting break of M. Guérin, 491.—Further investigation, at the instance of the Rolling Stock Committee of the Directors of the Lancashire and Yorkshire railway, to ascertain the retarding power of different breaks, and to obtain data relative to the rapidity with which a train could be brought to a stand, when travelling at a high rate of speed, so as to determine the value of the continuous self-acting breaks as compared with others, 492.—Dynamical laws affecting the case of trains on a level, and when the breaks are applied on an incline, 492.—Description of Mr. McConnell's break, 494.—Ditto Mr. Newall's and Mr. Fay's breaks, 494.—Ditto M. Guérin's break, 496.—Experiments with Mr. Newall's and Mr. Fay's continuous breaks, 497.—Ditto on the friction of the carriages, 501.—Ditto with slide breaks, with the engine detached from the train, 502.—Ditto with flap breaks, with ditto, 504.—Ditto with the engine attached to the train, 504.—General summary of results of experiments with Mr. Newall's and Mr. Fay's breaks, and conclusions deduced, 505.—Colonel Yolland's experiments compared with these results, 506.—Ditto on M. Guérin's self-acting break, 511.—Experiments on Mr. Ingram's auxiliary break by the Manchester, Sheffield, and Lincolnshire railway, 512.—Final reduction of retarding force to units of weight of the different break-carriages, 513.—General summary, 515.—Practical formulæ, 515.

Discussion. — Bamborough, —, 518.—Bidder, G. P., 525.—Bramwell, F. J., 519.—Broughton, F., 524.—Chambers, A., 524.—Hawkshaw, J., 523.—Hawksley, T., 520, 524.—Hemans, G. W., 518, 523.—Huish, Capt., 522.—Pole, W., 524.—Sinclair, R., 518.—Vignoles, C., 518, 521.—Wightman, A., 519, 524.

RAILWAY CURVES.

Railway bridge, cast iron, over a turnpike road, where the depth between the soffit of the bridge and the surface of the rails is limited to twenty-one inches (Pope, J.), i. (1841) 87.

— — — — —; Macdonald's patent, lii. 64.

Railway-carriage roof-lamps, Defries', xviii. 162.

RAILWAY CARRIAGE SPRINGS.

"Description of Lieutenant D. Rankine's spring contractor." By W. J. M. Rankine, ii. (1843) 111.—The strength and stiffness of the spring increased in proportion to the load placed upon it, 111.—Dimensions of the springs and contractors on the Edinburgh and Dalkeith railway, 111.—Advantages derived from their use, 112.

Railway carriage-wheels, description of a machine for bending and setting the tires of, (Woods, J.), i. (1841) 99.

RAILWAY CLOCKS.

"On the construction and regulation of clocks for railway stations." By B. L. Vulliamy, iv. 63.—Inconvenience of the difference between London time and correct mean time at different railway stations, and means of remedying it, 64.—On the two classes of clocks called spring and weight, 66.—Description of the former, and objections to it, 66.—Ditto of a weight clock for a railway station, 67.—Best situation for ditto, 68.—On their expense, 71.

Discussion.—Bidder, G. P., 75.—Brockedon, W., 75.—Curtis, J. G. C., 76.—Davison, R., 74.—Dent, E. J., 74.—Giles, A., 73.—Horne, J., 72, 73, 75.—Vulliamy, B. L., 72, 73, 76.—Walker, J., 72, 76.—Whishaw, F., 71.

RAILWAY CURVES.

"On setting out railway curves." By C. Bourns, i. (1840) 56.

"On setting out curves for railways." By R. C. May, i. (1841) 96.—Description of the instrument for, 97.

"Description of a method of laying down railway curves on the ground." By W. J. M. Rankine, ii. (1843) 108.—Mathematical principle of the method, 108.

Discussion.—Gravatt, W., 109.

RAILWAY CURVES AND INCLINES.

RAILWAY CURVES AND INCLINES.

"On the use of locomotive power, on gradients of 1 in 17, and curves of 300 feet radius, on railways in America." By T. S. Isaac, xviii. 51.—Expedients to facilitate the execution of the works, 51.—The Baltimore and Ohio railway, 52.—Incline over the main range of the Alleghany mountains, 52.—Locomotives used for working ditto, 53.—Temporary incline over the Kingwood tunnel, 54.—Ditto Broad Tree tunnel, 54.—The Virginia Central railroad, 55.—Mountain Top incline, 55.—Engines used on ditto, and loads conveyed, 56.—System of working adopted, 57.—Resistance offered by the sharp curves, and expedients resorted to for diminishing the friction, 59.—Calculations of the ordinary performances of the engines on the Mountain Top Track, 61.—Adhesive power of the engines on ditto, 61.—Practical inconveniences attending the use of stationary power, 62.

Discussion.—Barlow, P. W., 66.—Bidder, G. P., 69.—Clark, D. K., 65.—Colburn, Z., 63.—Coode, J., 69.—Gregory, C. H., 66.—Hawshaw, J., 67.—Hemans, G. W., 68.—Isaac, T. S., 64, 69.—Moorsom, Capt. W. S., 67, 69.—Peacock, R., 67.

Vide also LOCOMOTIVE ENGINES.

Railway cuttings, on the geological sections of, i. (1841) 61.

—, Ashley, Great Western railway (Thomson, J. G.), iii. 129.

—, New Cross, on the Croydon railway, iii. 132.

—, open, in place of tunnels, xiii. 477, 478.

—, slips of, iii. 145, *et seq.*

— *Vide also* CUTTINGS; LAND-SLIPS; and RAILWAY CUTTINGS AND EMBANKMENTS.

RAILWAY CUTTINGS AND EMBANKMENTS.

"On railway cuttings and embankments, with an account of some slips in the London clay, on the line of the London and Croydon railway." By C. H. Gregory, iii. 135.—Angles of repose of

RAILWAY ECONOMY.

various soils, 135.—New Cross cutting, 138.—Geology of the district, 138.—Progress of the slip, 139.—Method of removing the fallen earth, 140.—Causes of the slip, 141, 148.—Dip of the strata, 142.—Modes of prevention now adopted, 143.—Buttresses of gravel in the slopes, 144.

Discussion.—Braithwaite, F., 147, 169.—Bruff, P., 147, 158.—Buck, G. W., 153.—Clutterbuck, Rev. J. C., 154, 171.—Colthurst, J., 163, 168.—Cowper, E., 145.—De la Beche, Sir H., 155, 168, 169.—Dockray, R. B., 148.—Forster, F., 153.—Green, J., 169, 171.—Gregory, C. H., 148, 150.—Hawshaw, J., 152.—Hoof, J., 148.—Hughes, T., 171.—Moorsom, Capt. W. S., 157.—Pasley, Lieut.-Gen., Sir. C. W., 145, 148, 152.—Phipps, G. H., 147, 169.—Sibley, R., 168.—Simpson, J., 153.—Smith, J., 151.—Sopwith, T., 152.—Taylor, J., 150.—Thomson, J. G., 153.—Walker, J. 170.

Vide also CUTTINGS, and LAND-SLIPS.

RAILWAY ECONOMY.

"Observations on the present mode of executing railways, with suggestions for a more economical, yet equally efficient system, of both executing and working them." By F. Whishaw, i. (1839) 53.

"The economy of railways as a means of transit, comprising the classification of the traffic, in relation to the most appropriate speeds for the conveyance of passengers and merchandize." By B. Poole, xi. 450.—Expense of conveyance of merchandize, minerals, and agricultural produce, as compared with rates charged on canals and turnpike roads, 452.—Pecuniary saving to passengers and to Post-office by railways, 452.—Benefits to agriculturist, landowner, and farmer, 452.—Rates for carriage of live stock, 453.—Railways in Great Britain should be worked in four divisions, 453.—Uniformity in construction of stock, from a carriage to a screw, 454.—Merchandize waggons, 454.—Coke sheds should be provided at stations and

RAILWAY EMBANKMENTS.

junctions, 454.—Facilities that should be afforded at stations, 455.—Ordinary fares for passengers and rates for merchandize, 455.—General classification of goods by merchandize-trains upon all railways, 456.—Ditto of trains throughout the kingdom proposed, 459.—Appropriate average speed of trains, stoppages inclusive, 460.—Advantages and political economy of railway system, 460.—Saving to be effected by railway companies by decimalization of coins, weights, and measures, 460.

Discussion.—Barlow, P. W., 476.—Bidder, G. P., 469.—Brunel, I. K., 471.—Cawley, C. E., 477.—Fairbairn, W., 475.—Gregory, C. H., 465.—Harding, W., 461, 464, 469.—Hawkshaw, J., 464, 473.—Huish, Capt., 461, 463, 476.—Locke, J., 466, 468.—May, C., 461, 464, 470.—Macneill, Maj.-Gen., 475.—Pasley, Lieut.-Gen. Sir C. W., 475.—Poole, B., 464, 472.—Rendel, J. M., 477.—Slate, A., 468.—Stephenson, R., 462, 464, 468, 475, 476.

Postal facilities afforded by, (Stephenson, R.), xv. 133.—Extracts from second report of Postmaster-General on the Post-office relative to the postal effects of railways, 456.—Reply of Mr. R. Stephenson to ditto, 470.

Railway embankments. *Vide* CUTTINGS; EMBANKMENTS; RAILWAY CUTTINGS AND EMBANKMENTS; and SEA DEFENCES.

RAILWAY FERRIES.

"On the floating railways across the Forth and Tay ferries; in connection with the Edinburgh, Perth, and Dundee railway." By W. Hall, xx. 376.—Various proposals for, and reference to previous undertakings of a similar character, 377.—Description of the works at the Forth ferry, 377.—Details of the 'Leviathan' steam-vessel for conveying the goods traffic across the Forth, 381.—Cost of the works on the Forth, at Granton and Burntisland, and the working expenses, 382.—Description of the works at the Tay ferry, and of the steam-vessel 'Napier,' with their cost,

RAILWAY INCLINES.

383.—Proposal to establish some such mode of communication across the Straits of Dover, 384.

Discussion.—Bateman, J. F., 386.—Bidder, G. P., 389.—Bouch, T., 383, 387, 389.—Curtis, J. G. O., 388.—Greaves, C., 386, 389.—Hall, W., 388.—Harrison, T. E., 386.—Murray, J., 388.—Ormiston, T., 388.—Sheilda, F. W., 388.—Vignoles, C., 387.

Vide also FERRIES.

RAILWAY INCLINES.

Apparatus for ascending, (Cristoforis, Signor de), xvii. 16.

High Peak (Homersham, S. O), v. 157.

Lancashire and Yorkshire railway, Oldham branch. "Description of the mode of working an incline of 1 in 27½, on the Oldham branch of the Lancashire and Yorkshire railway." By Capt. J. M. Laws, x. 246.—Originally proposed to be worked by a horizontal wheel, rope, and pulleys, with a locomotive at each end of the rope, 246.—Now worked by a combination of locomotive power and gravity, 246.—Experiments to test power of locomotive on this incline, 248.—Opportunity of testing the merits of R. S. Newall and Co.'s wire-rope, 248.

Discussion.—Harding, W., 250, 255.—Harrison, T. E., 252.—Hawkshaw, J., 249, 254, 256.—Laws, Capt. J. M., 248, 254.—Moorsom, Capt. W. S., 251, 254.—Pim, J., 254.—Sinclair, A., 252.—Stephenson, R., 253, 254, 256.

Lickey, on Birmingham and Gloucester railway, and engines used in working it, &c., ii. (1843) 99, *et seq.*

Mode of working. "On steep gradients of railways, and the locomotives and stationary engines employed." By C. R. Drysdale, xv. 349.—History of the construction of the Semmering incline on the railway connecting Vienna with Trieste, 349.—Inquiry into the methods of working steep gradients in different countries, 350.—Determination to employ locomotives, 350.—Description of the works, gradients, and curves of the Semmering incline, 350.—Prize pro-

RAILWAY INCLINES.

posed by the Austrian Government, in 1850, for the best locomotive, 352.

—Description of the type of engine now in use, its weight, and capabilities in proportion to the weight, 353.—Description of the Giovi incline for surmounting the Apennines, near Genoa, 357.—Locomotive power employed for ascending ditto, 358.—Results of the working of steep gradients, in England, by locomotives, 359.—Ditto, the Glasgow incline, on the Edinburgh and Glasgow railway, by a stationary engine and rope, 360.—Ditto, of the atmospheric system, on an incline on the St. Germain railway, 361.—Comparison of the duties of the last-constructed engines for the Semmering and Giovi inclines with those used on English railways, as to evaporating power, horse power, per cubic foot of water evaporated, and weight drawn in proportion to the weight of the engine, 361.—Comparison with lines worked by stationary engines and ropes, and by the atmospheric system, 363.

Discussion.—Bidder, G. P., 372.—Cramp-ton, T. R., 373.—Drysedale, C. R., 374.—Fairbairn, W., 371.—Hawthaw, J., 366, 368.—Jee, A. S., 369.—Moorsom, Capt. W. S., 365, 368, 374.—Weallens, W., 373.—Wood, N., 371.—Woods, E., 370.—Vignoles, C., 368.

Safety drag for. "Description of a safety drag, or apparatus for preventing accidents to trains ascending inclined planes, used on the Edinburgh and Dalkeith railway since 1832." By W. W. J. M. Rankine, iii. 284.

Waterford and Kilkenny. "Statement of observations made during the running of the ordinary trains on the inclined planes of the Waterford and Kilkenny railway, between the months of August, 1848, and January, 1849." By Capt. W. S. Moorsom, viii. 287.—Appendix, Table I. Abstract of observations on the velocities of trains, during eighty trials, 289.—Table II. Down an incline of 1 in 100, without steam, with a speed at the top of the

RAILWAY SIGNALS.

incline of from 20 to 25 miles per hour, 290.—Table III. Ditto, from 25 to 30 miles per hour, 291.—Table IV. Ditto, ditto, 292.—Table V. Ditto, from 30 to 35 miles per hour, 293.—Table VI. Ditto, ditto, 294.—Table VII. Ditto, from 35 to 40 miles per hour, 295.—Table VIII. Ditto, from 40 to 45 miles per hour, 295.

Discussion.—Moorsom, Capt. W. S., 296.

Vide also LOCOMOTIVE ENGINES; RAILWAY CURVES AND INCLINES; and RAILWAY TRAINS, RESISTANCES TO.

RAILWAY JUNCTIONS.

"On railway junctions." By A. Beaulands, vii. 204.—New method of setting out, 204.—Tables to facilitate ditto, 209.

Discussion, 210.

Railway key and trenail machinery, Ramsome and May's, cross-cut saw used in, xvii. 24.

— machine, Molesworth's, xvii. 31.

Railway locomotive stock, on the improvement of, and the reduction of the working expenses (Clark, D. K.), xv. 496; xvi. 8.

Railway money chest, vii. 185.

Railway safety drag, used on the Edinburgh and Dalkeith railway (Rankine, W. J. M.), iii. 284.

RAILWAY SECTIONS.

Collections of, in the Museum of Economic Geology (Sopwith, T.), iii. 134.

"Manchester and Leeds railway section." By F. Whishaw, i. (1839) 43.—Arrangement of sections, for evidence before parliamentary committees, 43.

Method of laying down, so as to show at one view the position of the cuttings and embankments, i. (1837) 36.

Railway semaphores, application of electric telegraph to, xi. 378.

Railway siding stop, Beekers', x. 58.

—, Gregory's, (C. H.), x. 192.

Railway signal whistle, description of, iv. 150.

RAILWAY SIGNALS.

"Description of a self-acting signal for railways." By C. B. Curtis, ii. (1842) 186.

RAILWAY SLEEPER.

Experiments on the use of maroons (Cowper, E. A.), i. (1841) 116; (Gregory, C. H.), 116.

Gibson's self-acting, xvii. 51.

Railway sleeper, specimen of white cedar, from Bathurst, New Brunswick (Churchill, —), i. (1840) 44.

RAILWAY STATIONS.

Arrangement and construction of. "On the arrangement and construction of railway stations." By B. J. Hood, xvii. 449.—Want of published information on the subject, for the use of the engineering student, 449.—Superiority, as to convenience and effect, of the stations upon the Continental lines of railway, 449.—Selection of sites for terminal and other stations, 450.—Difference of opinion, as to the expediency of providing new lines of railway, with complete station appliances, 451.—Railway officers should be able to understand plans, or drawings of works, affecting their several departments, and the resident engineer should in all cases design the station works, 452.—Details of the terminal station, 452.—The approaches, roads, and yards, 452.—Position of the main buildings relative to the direction of the lines of rails, and the comparative advantages of the parallel, or side-station system, the transverse, or end-station system, and a combination of both systems, the offices being situate in a fork, 453.—Waiting-rooms, and offices for booking passengers, parcels, and luggage, and for the telegraph, cloak-room, and lost-property office, 457.—Construction of the platforms, 459.—Ditto of the platform and station-sheds, 460.—Best position for, and details of construction of, horse and carriage docks, 461.—Lines of rails for trains, spare carriages, and locomotives, 461.—Turn-tables, traversers, points and crossings, and moving platforms, 462.—Paving the station area, 463.—Engine stable and pits, 463.—Water-tanks, cranes, hydrants, and coke-stage, 463.—Ticket platforms, carriages in wait-

RAILWAY STATIONS.

ing, and means of egress, 464.—Mess-rooms and conveniences for engine-drivers, guards, porters, &c., 465.—Workshops for local repairs, 465.—Stabling for post-horses, &c., 465.—Construction and arrangement of the closets and urinals, 465.—Provisions for lighting, watering, cleansing, and watching, 466.—Terminal station of a double line of railway, in an important town on the coast, accommodating the traffic and trains of two separate companies, 466.—Ditto, of a small, single-line branch, 468.—Ditto, adapted for the working of unusually heavy passenger-traffic, on particular occasions, such as races or fairs, 470.—Intermediate stations, 471.—Plan of making the trains cross to the passengers, with one platform only, 473.—Modification of ditto, where, from the position of a level crossing, a double platform, of sufficient length, could not be obtained, 473.—Plan of arranging the ends of the platforms nearly opposite to each other, with a paved crossing between, 475.—Intermediate stations in a cutting, 475.—Junction stations, where two double lines of railway converge, 476.—Plan of placing the buildings and yards in the fork between the two, 476.—Ditto beyond the point of junction, 476.—Junction stations for single-line branches, 478.—Want of uniformity in the description of signals used, and in the method of working them, 480.

Discussion.—Locke, J., 482.

Camden. "Description of the Camden station of the London and North Western railway." By R. B. Dockray, viii. 164.—This station at first intended as the sole terminus of the line, 164.—Extension to Euston Grove, 164.—Dates of the opening of different portions of the London and Birmingham railway, 164.—Works on the old Camden station, 165.—Necessary to remodel the station, owing to the increase in the goods traffic, the change in the system of conducting that de-

RAILWAY STATIONS.

- partment, and the increase of speed in the passenger-trains, 165.—Want of sufficient sidings for marshalling the goods-trains, 166.—Stationary engines and rope for working the Euston incline abandoned, in April, 1844, 167.—Increase in the dimensions of the locomotive engines, position of the old engine-house, and of the two new engine-houses, 167.—Works executed since the general opening of the railway, 167.—The passenger engine-house, coking-shed, offices, stores, &c., 168.—The goods engine-house, &c., 168.—The construction-shop for the repair of goods-waggons, 169.—Removal of the old Chalk Farm Lane bridge, and description of the new one, 169.—Bridge over the Regent's canal, 170.—Cattle landing and pens, and dock adjoining the canal, 170.—Extent of the works, 170.—Original water supply, derived from a well sunk into the green-sand, found to be unfitted for the locomotives, 171.—Supply obtained from the Regent's canal, 171.—In new arrangement of the station a well was sunk into the chalk, 171.—Analyses of the water from the wells at the Tring, Watford, and Camden stations, 172.
- Discussion.—Bidder, G. P., 176.—Braithwaite, F., 178, 185.—Brunel, I. K., 183.—Buckland, Dr., 173, 177.—Clark, T., 176.—Davison, R., 185.—Dockray, R. B., 176, 177.—Donkin, J., 176.—Graham, Prof., 174.—Harding, W., 177, 180.—Hawksley, T., 184.—Homersham, S. C., 184.—Maudslay, H., 176.—Maugham, W., 181, 184.—May, C., 179, 184, 185.—McConnell, J. E., 178.—Moorsom, Capt. W. S., 177, 179.—Paton, —, 185.—Russell, J. S., 185.—Stephenson, R., 182.—Ure, Dr., 175, 176.—Wicksteed, T., 184.
- Eastern Counties, London terminus. "Description of the iron shed at the London terminus of the Eastern Counties railway." By W. Evill, Jun., iii. 288.
- Shields, on the Newcastle and North

RAILWAY SYSTEMS.

- Shields railway (Green, B.) i. (1841) 90; v. 230.
- Railway switches and crossings, Faram's, iii. 127; Carr's, xiii. 437; Burleigh's, xiv. 19; Hurry's, xvi. 298; Ransome and Biddell's solid chilled crossing, 299.

RAILWAY SYSTEMS.

Brazil (Annual Report), xix. 152.

- France. Sketch of the principles and character of the French railway system (Looka, J.), xvii. 128.—Origin, progress, and results, strikingly dissimilar to those of English railways, 129.—Contrasted results, 129.—Essential characteristics of the French system, the determination by the State of its lines of railway, 130.—The second leading object, the process which the State employs to obtain the desired progress in their construction, 130.—Security from that species of competition which has been the bane of English railways, 130.—Preliminary steps, or 'fixed machinery' of railway concessions, 181.—Variations in the terms of concessions, 133.—Law of the 11th June, 1842, 133.—Lines comprised in the concessions of 1842, 134.—System of 'subvention,' or gross amounts supplied by the State in successive years, 135.—Table showing the whole financial condition of the French railways, 135.—Proportion of the share capital to the amount raised on obligations or bonds, 137.—Net receipts of railways from 1841 to 1854, and the percentage of dividend, 138.—Provision made by law for extinguishing the capital, 139.—Comparison of the cost of French and English railways, 140.—Greater facilities which the physical features of the country present in France, 140.—Other causes beneficial to railway property in France, 141.—Advantages which French railways have enjoyed as compared with English railways, 142.—Introduction into France, by Mr. Brassey and Mr. Mackenzie, of machinery and skilled labour, particularly of the class of 'navvies,' 143.—Com-

RAILWAY SYSTEMS.

plaint regarding the employment of Englishmen in France, 144.—Determination to establish workshops at Rouen, for the supply of engines and carriages, 144.—Engines employed on French railways becoming very heavy, 145.—Particulars as to the construction of French railways, 145.—Employment of females on French lines, 146.—Difference in the conduct of works by French and English engineers, 146.—Peculiarity incidental to the system, Government inspection, 148.—Retrospect, respective character of the lines, 149.—Financial elements of the subject, 150.—Table showing the proportion of the net produce of the working of each line to the prime cost, 152.

Great Britain (Cubitt, Sir W.), ix. 141; (Rendel, J. M.), xi. 151; (Huish, Capt. M.), 462; (Stephenson, R.), 462.

India (Rendel, J. M.), xi. 153.

Ireland (Rendel, J. M.), xi. 152.

— "On the railway system in Ireland, the Government aid afforded, and the nature and results of county guarantees." By G. W. Hemans, xviii. 24.—Contrast between the position of British and French railways, as investments, 24.—Result of the railway mania in England, 24.—Appointment of a Commission to inquire into the manner in which railway communications could be most advantageously promoted in Ireland, 25.—Extract from the Second Report of that Commission, as to the social condition of the population, 25.—Main recommendations of that Commission examined in reference to the actual results, 26.—As no steps were taken by the Government, the various lines were made with little regard for a national system, 27.—Length of railways authorized to be made in the United Kingdom during the years 1846-50, 28.—Lord George Bentinck's suggestions for Government interference in the construction of Irish railways, defeated in Parliament, 28.—Expenditure on so-called relief-works,

RAILWAY TRAINS.

29.—Aid given to railways through the agency of the Public Works Loan Commission, 29.—List of companies, showing the length of each, amount of loan and rate of interest, 30.—Only the Midland Great Western, granted on the principle recommended by the Commissioners; that is, a low rate of interest, guaranteed by a local rate, and an additional rate as a sinking fund, 30.—Table showing the progressive diminution of the compulsory rate levied in Galway and Roscommon, 32.—Desire to extend the guarantee system defeated by official opposition, 33.—Arguments in favour of the guarantee system, 33.—Table showing the length of lines in operation, capital, and dividends, 34.—Comparison of results with some of the expectations of the Commission, 34.—Main feature of the Irish traffic, 35.—Benefits conferred on Ireland by the Encumbered Estates Court, 35.—Appendix—Table giving the details of the cost, per mile, of some of the leading Irish lines, 38.

Discussion.—Barlow, P. W., 42.—Bidder, G. P., 44.—Brunlees, J., 46.—Curtis, J. G. C., 47.—Gisborne, L., 40, 43.—Hawkshaw, J., 43.—Hemans, G. W., 43, 47.—Locke, J., 48.—May, C., 43.—Roney, Sir C., 41.—Webster, T., 41.

Spain, Lombardy, Piedmont, Portugal, Russia, Turkey, and Egypt (Annual Report), xviii. 166; xix. 148.

United States of America (Rendel, J. M.), xi. 156.

Railway trains, O'Neill's iron telegraph for, xvii. 539.

RAILWAY TRAINS, RESISTANCES TO.

"On the resistances to railway trains at different velocities." By W. Harding, v. 369.—Summary of the series of experiments, 370.—Object of the paper, to present results from ditto, 372.—Conditions under which the experiments have been examined, 373.—Difference of opinion amongst engineers on the subject, 374.—Extract from Mr. Samuda's evidence, given before a Committee of the House of

RAILWAY TRAINS.

Commons, on the Newcastle and Berwick railway, 6th May, 1845, on an atmospheric railway, 374.—Analysis of the experiments of the Committee of the British Association, appointed in 1837, 376.—Ditto made by Mr. Scott Russell, in 1845, 377.—Ditto of the table of experiments on the Dalkey railway, compiled by Mr. Bidder, 380.—Ditto of the experiments made by Mr. Harding, in May, 1845, on the Bristol and Gloucester railway, 381.—Ditto ditto, on the Croydon atmospheric railway, in 1846, 383.—Ditto with locomotive engines, ordered by the Gauge Commissioners at the end of 1845, 389.—Mr. D. Gooch's experiments and evidence on ditto, examined, 390.—Observations on experiments made with M. Morin's dynamometer, by Mr. Scott Russell, on the South Eastern railway, 395.—Summary of results, and table of ditto, 399.—Observations on the three different modes of measuring the resistances, as given in the above experiments, 401.—Ditto on the selection of the above experiments, and the reasons, 402.—Ditto on the difference in effect between a directly favourable wind, and a directly adverse wind, 404.—Investigation of a formula representing the resistances of trains, 404.—Table to facilitate the calculation of the resistances to passenger-trains, under certain conditions, 407.—Application of the foregoing results to practice, 408.

Discussion.—Bidder, G. P., 417, 421, 425, 429.—Braithwaite, F., 422, 427.—Crampton, T. R., 428, 430.—Harding, W., 411, 414, 415, 417, 420, 425, 430, 432.—Hawkesley, T., 427.—Homer-sham, S. C., 422.—Rennie, G., 419.—Rennie, Sir J., 415, 432.—Russell, J. S., 411, 421.—Samuda, J., 414, 423, 427, 431.—Stephenson, R., 418, 420, 422, 426, 430, 432.—Woods, E., 413.

Resolution relative to making an application to the Croydon railway company to permit some experiments to be made "on the resistance to railway trains at different velocities," v. 434.

RAILWAYS.

"Observations on the resistances to railway trains at different velocities." By D. Gooch, vii. 292.—Mode of conducting the experiments, 292.—The deductions from Mr. Wyndham Harding's formula reviewed, 293.—Other resistances besides those of the atmosphere, with the amount of the latter, 293.—Elements to be determined by experiments, before any general formula can be made, 293.

Discussion.—Bidder, G. P., 302, 307, 308, 313, 321.—Braithwaite, F., 324.—Brunel, I. K., 299, 306, 308, 318.—Crampton, T. R., 320.—Fox, Sir C., 320.—Gooch, D., 306, 309, 318.—Harding, W., 295, 308, 315, 322, 326.—Hawkesley, J., 325, 326.—Locke, J., 305, 306, 309, 317, 320.—Moorsom, Capt. W. S., 317.—Russell, J. S., 294, 305, 318, 322, 326.—Stephenson, R., 314, 320, 324, 325.—Thomson, J., 325.

Vide also RAILWAY CURVES AND INCLINES; and RAILWAY INCLINES.

Railway viaducts, cost of, xiv. 209, 504.

Vide also VIADUCTS.

RAILWAYS.

American. "On railways in America."

By S. W. Roberts, i. (1839) 43.

— (Annual Report), xx. 17.—'Trellis railway', vi. 60, *et seq.*

Amsterdam and Rotterdam. "Account of the railway from Amsterdam to Rotterdam, and of the principal works upon it." By the Chev. F. W. Conrad, translated from the French by C. Manby, iii. 173.—Formation of the company, 173.—Defective state of the law of expropriation, 174, 176.—Bridges on the line, 174, 180.—Stock of the company, 177.—System of weights and measures employed, 177.—Materials used, 177.—Conditions to be observed by the contractors, &c., 177.—Construction of the permanent way, 178.—Earthworks, 179.—Stations and workshops, 179.—Foundations for the buildings, 179.—Method of cutting off the heads of the piles under water, 189.—Population of the towns through which the railway passes, 195.—Fares

RAILWAYS.

and statement of the number of passengers, 195, 196.—Locomotive engines, &c., employed on the line, 196.

— Description of the method adopted in preparing the foundation, and building the bridge over the Poldevaart (Conrad, Chev.), vi. 149.

Australian (Annual Report), xx. 111.

Birmingham and Gloucester, account of, (Jackson, G. B. W.), ii. (1842) 53.—Cast-iron bridge over the Avon, near Tewkesbury (Moorsom, Capt. W. S.), iii. 60.—Geology of the line, 62.

Birmingham extension. "An account of the works on the Birmingham extension, of the Birmingham and Oxford Junction railway." By C. B. Lane, xi. 69.—Situation of the town of Birmingham, 69.—Description of the line, 69.—Trial shafts for ascertaining nature of strata, 69.—Dimensions of viaduct, and materials employed, 70.—Experiments as to weight of bricks when dry and when saturated, 71.—Composition of mortar used on works, 71.—Weight of ditto when dry and when wet, 71.—Ditto of piece of sandstone ditto, 71.—Test of qualities of mortar, 71.—Details of centres, 72.—Progress of works, 73.—Settlement of arches, 73.—Observations on blasting rock, to ascertain expenditure of labour and gunpowder per cubic yard, 74.—Park-street bridge, 74.—Allison-street bridge, 75.—Meriden-street bridge, 75.—Oxford-street bridge, 75.—Floodgate-street bridge, 76.—Adderley-street bridge, 76.—Work done per day by each bricklayer, and amount of assistant labour required, 76.—Details of tunnel, 77.—Moor-street bridge, 77.—Description of means adopted for raising materials, 77.—Observations as to useful effect produced by 'labouring force,' 'travail mécanique,' of a man, and also of a horse, 77.—Horse-run lift, 78.—Swing-lift, 78.—Box lift, 79.—Relative cost of raising by horse-run lift, 79.—Mean calculated efficiency of swing-lift, 80.—Ditto of box-lift, 80.—Relative cost of raising material by horse-lift,

RAILWAYS.

swing-lift, and box-lift, 80.—Observations on amount of material raised by hod-men, 81.

Blackwall, friction of the stationary engines (Field, J.), ii. (1843) 70.—Description of ditto (Robertson, A. J.), v. 148.

Bolton and Preston, bridges on the, (Adie, A. J.), ii. (1842) 176.—Chorley cutting (Pasley, Lieut.-Gen. Sir C. W.), iii. 367.

Bordeaux and Bayonne, through the Grandes Landes (Conder, F. R.), xvi. 371.

Brazil (Annual Report), xvi. 90; xix. 152.—Mauá, the first Brazilian railway (Webb, E. B.), 240. *Vide also PUBLIC WORKS IN BRAZIL.*

British (Simpson, J.), xiii. 193; (Annual Report), xiv. 102.

— (Stephenson, R.), xv. 123.—Length, 124.—Cost, 124.—Magnitude of works, 125.—Extent of working, 125.—Traffic, 126.—Wear and tear, 127.—Renewal fund, 128.—Valuations of rolling stock, 129.—Fares, 131.—Postal facilities, 133.—Legislation for railways, 135.—Management, 141.—Electric telegraph, 144.—Railway accidents, 147.—Railway results, 149.—Practical application, 152.

—, average apportionment of the receipts on, (Clark, D. K.), xvi. 21.

Caen and Cherbourg (Annual Report), xviii. 166.

Canada, and through traffic arrangements in connection with, (Annual Report), xvii. 74.

Canterbury and Whitstable, experiments on the Tyler Hill inclined plane, showing the relative amount of lost power by the rope traction, as compared with that of the atmospheric system, on the Dalkey inclined plane (Barlow, P. W.), iv. 122.

Cape of Good Hope (Annual Report), xx. 109.

Castle Douglas and Dumfries (Annual Report), xix. 140.

Charing Cross (Annual Report), xix. 135.

Chester and Holyhead, sea-walls at Pen-

RAILWAYS.

- maen Mawr (Swinburne, H.), x. 257.—Potts' pneumatic cylinders for forming artificial foundations, first applied to a bridge on the, (Clegg, S.), 319.
- Colonial (Rendel, J. M.), xi. 153; (Annual Report), xiv. 100.
- Competition of canals with, xiii. 211, *et seq.*
- Continental (Rendel, J. M.), xi. 154; (Annual Report), xiv. 100.
- Denmark between Tønning and Flensburg (Annual Report), xiv. 101.—Execution and supervision of railway works (Bidder, G. P.), xviii. 22.
- Dublin and Drogheda, wrought-iron lattice bridge upon, (Hemans, G. W.), iii. 63.
- Dublin and Kingstown, application of the atmospheric railway system (Rennie, Sir J.), v. 80.
- Eastern Counties, skew bridges upon, (Dobson, E.), ii. (1842), 90.—Cuttings (Pasley, Lieut.-Gen. Sir C. W.), iii. 146; (Phipps, G. H.), 147.
- Edinburgh and Glasgow, expense of working the Glasgow incline (Moorsom, Capt. W. S.), ii. (1843) 103.
- Egypt (Rendel, J. M.) xi. 154; (Sopwith, T.), xvii. 53; (Stephenson, R.), 66; (Annual Report), xix. 142.
- Furness, on the construction and enlargement of the Lindal tunnel on the (Stileman, F. C.), xix. 229.
- Great Northern (Rendel, J. M.) xi. 151.
- Great Western, description of the tunnels between Bristol and Bath (Nixon, C.), ii. (1842), 138.—Expense of working the Box tunnel incline (Moorsom, Capt. W. S.), ii. (1843), 103.—Hydraulic traversing frame at Bristol terminus (Dodson, A. J.), iii. 128.—Land-slip in Ashley cutting (Thomson, J. G.), 129.—Dimensions of the carriages (Pasley, Lieut.-Gen. Sir C. W.), v. 244.
- Hagger Leases branch, Durham; oblique bridge over the river Gaunless (Storey J.), iv. 59.
- History of, (Rennie, Sir J.), v. 68.
- Huddersfield and Sheffield, description of the Lockwood viaduct on the, (Haw-

RAILWAYS.

- shaw, J.), x. 296.—Ditto, of the Peni stone viaduct, 299.
- Hull and Selby, trenails used on, ii. (1842) 79.—Description of the Ouse bridge (Bray, W. B.), iv. 86.
- Indian (Rendel, J. M.), xi. 153; (Annual Report), xvi. 89; (Tremenheere, Maj.-Gen. G. B.), xvii. 507, *et seq.* *Vide also* PUBLIC WORKS.—Sufferings and conduct of the engineers during the mutiny and defence of Arrah by Mr. Boyle (Annual Report), xviii. 165.—East Indian, xix. 143.—Great Indian Peninsular, 144.—Madras, 145.—Scinde and Punjab, 145.—Eastern Bengal, 146.—Great Southern, 146.—Calcutta and South Eastern, 146.
- “On Indian railways: with a description of the Great Indian Peninsular railway.” By J. J. Berkley, xix. 586.—Importance of railways in British India, 586.—Arrangements entered into by the Government for the establishment of a system of railways, and terms of the contract between the Government and the companies, 587.—Advantages of the guarantee system, and disadvantages of the minute supervision exercised by the authorities, 588.—Standard dimensions adopted on Indian railways, 589.—The Great Indian Peninsular railway, 590.—Population of Bombay, preponderance of trade to, amount of exports and imports, 590.—Traffic which will be commanded by the railway, 591.—The Syhadree mountains, 591.—Effect of the railway system upon the commercial transactions relative to cotton, 592.—The principal works upon the experimental line from Bombay to Callian, 592.—Ditto upon the south-eastern extension from Callian to Campoollee, 593.—Ditto upon the Bhore Ghaut incline, 594.—Comparative table of the Bhore Ghaut and of the Giovi and Sömmering inclines, 595.—Principal works upon the south-eastern extension from Lanowlee to Sholapore, 596.—Ditto upon the first section of the north-eastern extension from Callian to Kussarah, 596.—Ditto

RAILWAYS.

upon the Thul Ghaut incline, 597.—Ditto upon the north-eastern extension from Egulpoora, by Nassick, to Bhosawul, 597.—Ditto upon the last section of ditto, from Bhosawul to Jubbulpoor, 598.—Ditto upon the Oomrawuttee and Nagpore branch, 598.—General style of design for these trunk lines, 598.—Geological nature of the country, 599.—Physical geography of the districts of Western India traversed by the railway, 600.—Amount of rainfall during the year 1858, at different places upon and near the western coast, 601.—Railway materials procurable in India, 601.—Properties of some of the various kinds of wood, 602.—Cost of sleepers, and immunity from the ravages of the white ant when laid in the ballast, 602.—Building stone, bricks, and lime, 602.—Rise in the prices of materials, and irregularity in obtaining supplies, 603.—Use of Greaves' iron sleepers, and of creosoted sleepers, 604.—Iron goods shed and iron booking office, 604.—Character of the native labour, 604.—Rates of wages per day of several classes of native labourers, and relative cost of each kind of labour in England and in the Bombay Presidency, 605.—Adoption of the English contract system, and effect of its introduction into India, 606.—The engineering staff, 607.—Methods of executing the work, 607.—Average cost of the opened portions of the line, and prices of the principal kinds of work, 609.—Effects produced by railway enterprise in Western India, 610.

Discussion.—Berkley, G., 611.—Bidder, G. P., 623.—Bruce, G. B., 617.—Hawkshaw, J., 621.—Longridge, J. A., 620.

Ireland (Rendel, J. M.), xi. 152; (Hemans, G. W.), xviii. 24, *et seq.*; (Annual Report), xix. 140. *Vide also RAILWAY SYSTEM, Ireland.*

Kingstown and Dalkey, iii. 269, 273.

Lancashire and Yorkshire, Oldham branch, description of the mode of working an incline of 1 in 2½, on the,

RAILWAYS.

(Laws, Capt. J. M.), x. 246.—Plan adopted, in 1845-46, to show that the rates on the Lancashire and Yorkshire railway were too low, (Hawkshaw, J.), xviii. 44.

Liège and Verviers. "An account of the railroad constructing between Liège and Verviers, Belgium." By Lieut. Oldfield, ii. (1842) 141.

Lisbon and Santarem. "Description of the line and works of the railway from Lisbon to Santarem." By J. S. Valentine, xviii. 1.—The first railway in Portugal, 1.—Want of means of internal communication in that country, 1.—Method of granting concessions, its advantages and disadvantages, 2.—Concessions already granted for railways in Portugal, and terms on which they have been taken, 5.—Mode of obtaining the land for railways, either by private agreement or by legal expropriation, 5.—Preliminaries connected with the definite concession for the line from Lisbon to Santarem, 7.—Material alterations suggested in the route of the proposed line, 7.—Inauguration of the works, organization of the company, and letting of the contract, 8.—Site of the Lisbon terminus, and description of the line and works, 8.—List showing the number, rate of inclination, and length of each class of gradient, 10.—Amount of earthwork on the line, 11.—Geological character of the cuttings, &c., 12.—Difficulties encountered in the construction of some of the embankments, 12.—Requirements of the Government as to the size of road-bridges, 13.—Viaduct at Xabregas, 14.—Bridge over the navigable river Sacavem, 14.—Details of the permanent way, 15.—Probable traffic in passengers and goods, 16.

Discussion.—Bidder, G. P., 22.—Flanagan, T., 18.—Hawkshaw, J., 20.—Molesworth, G. L., 18.—Russell, J. S., 19.—Valentine, J. S., 20.

Liverpool and Manchester, stationary engines at the new tunnel on the, (Grantham, J.), i. (1841) 146.—Coke

RAILWAYS.

- consumed by the locomotives per mile (Braithwaite, F.), ii. (1843) 102.—History of the railway (Rennie, Sir J.), v. 71, *et seq.*
- London and Birmingham, performances of the locomotive engines, during the year 1839 (Bury, E.), i. (1840) 83.—Repairs done to the Beechwood tunnel on the, September, 1840 (Smith, T. M.), i. (1841) 142.—Iron skew bridge over the Regent's canal (Dobson, E.), ii. (1842) 90.—Expense of working the Euston-square incline (Moorsom, Capt. W. S.), ii. (1843) 103.—Yielding of the retaining walls of the Euston incline cutting (Cowper, E.), iii. 145; (Hoeking, Prof.), 357.—Method employed in draining some banks of cuttings (Hughes, T.), iv. 78.—Estimate for applying the atmospheric railway system to it (Barlow, P. W.), 118; (Stephenson, R.), 258.
- London and Croydon, method employed in draining some banks of cuttings (Hughes, T.), iv. 78.—Application of the atmospheric railway system to, (Rennie, Sir J.), v. 80.
- London and North Western, description of the Camden station of the, (Dockray, R. B.), viii. 164.—Analysis of 1,000 cases of engine-failures and defects, occurring on the, and subsidiary lines (Huish, Capt. M.), xi. 440.—Effect of electric telegraph in working ditto, during the Great Exhibition, and amount of traffic at that period, 447.
- Madras, facts regarding the, and description of the method of building bridges upon brick wells in sandy foundations; illustrated by the viaduct over the river Poiney (Bruce, G. B.), xvi. 449.—On the permanent way of the, (M'Master, B.), xviii. 417.—Works recently completed (Annual Report), xix. 145.
- Manchester and Bolton tunnel (Hawshaw, J.), iii. 152.
- Mauritius (Annual Report), xix. 148.
- Metropolitan (Annual Report), xix. 135.
- Middleborough, stone bridge on the, (Harris, J.), i. (1841) 136.
- Newcastle and Carlisle, first model of an

RAILWAYS.

- arched timber viaduct submitted to the company, for crossing the river Tyne, above Sootswood (Green, B.), v. 221.
- Newcastle and North Shields, description of the arched timber viaducts (Green, B.), i. (1841) 88; v. 219.
- North Midland, accident upon, (Pasley, Lieut.-Gen. Sir C. W.), ii. (1843) 93.
- Norway (Annual Report), xiv. 101.—Terms of concessions (Bidder, G. P.), xviii. 22.
- Panamá (Bendel, J. M.), xi. 156.
- Paris and Rouen, notice of the principal bridges on the laminated principle (Green, B.), v. 232.
- Peak Forest, summit level of the, (Hommersham, S. C.), xiii. 210.
- Portsmouth (Annual Report), xix. 86.
- Running gauge for ascertaining the parallelism of, (Cowper, Prof.), i. (1840) 30.
- Russia, Riga and Dunaberg (Annual Report), xix. 151.—St. Petersburg and Warsaw, the Riga-Dunaberg, and the Moscow and Nijni Novgorod (Annual Report), xx. 117.
- St. Helens, mode of working the, and reduction of incline planes (Sinclair, R.), x. 252.
- Salisbury and Yeovil (Annual Report), xix. 137.
- Severn Valley (Annual Report), xix. 136.
- Shrewsbury and Crewe (Annual Report), xix. 136.
- South Eastern, permanent way (Pope, J.), ii. (1842) 72.—Brickmaking at Blechingley tunnel (Simms, F. W.), ii. (1843) 145.—Works near Dover for carrying the railway along the sea-shore (Cubitt, Sir W.), x. 276.
- South Wales, prolongation of, (Bendel, J. M.), xi. 151.
- South Western, cost of horses on the contract works (Horne, J.), ii. (1843) 117.
- Spain. Guarantees (Curtis, J. G. C.), xviii. 47.—'Zig-zag' system of construction, for crossing high mountains, first proposed for traversing the Guadarama Pass (Coode, J.), 69.—Rapid extension of the railway system (Annual

RAILWAYS.

- Report), xix. 148.—The Northern, 149.—The North Eastern, 149.—The Biscayan, 149.—Speed of travelling on, remarks as to the present, xx. 275, *et seq.*
- Street, in United States (Adams, W. B.), xi. 269.
- Traffic on, in respect of wear and tear, xiv. 431, *et seq.*
- Ulverstone and Lancaster (Rendel, J. M.), xi. 152.—Description of the iron viaducts erected across the tidal estuaries of the rivers Leven and Kent, in Morecambe Bay (Brunlees, J.), xvii. 442.
- United States. Rapid development of the railway system (Rendel, J. M.), xi. 155.—Construction of the engines and carriages used on railways in the United States, and cost of construction of the railways in the States of Massachusetts and New York (Gregory, C. H.) xviii. 66.
- , Street railways (Adams, W. B.), xi. 269.
- Victor Emmanuel (Annual Report), xvi. 91.
- Victoria Station and Pimlico (Annual Report) xix. 135.
- Waterford and Kilkenny, construction of permanent way of, (Adams, W. B.), xi. 281.
- West Cornwall, remarks as to mode of working incline planes on the, (Moorson, Capt. W. S.), x. 251.
- West Durham, description of an oblique timber bridge, on the laminated principle erected across the river Wear, and its cost (Green, B.), v. 229.
- West London extension (Annual Report), xix. 186.
- West Riding Union, description of the Hall Bottom Viaduct on the, (Hawshaw, J.), x. 298.
- Wishaw and Coltness, Calder viaduct (Macneill, Sir J.), ii. (1842) 189.
- York, Newcastle, and Berwick, description of the Royal Border bridge, over the river Tweed, on the, (Bruce, G. B.), x. 219.
- Vide also RAILWAY ECONOMY, and RAILWAY SYSTEMS.*

RANKINE.

- Railways of continuous bearing, on the construction of, (Reynolds, J.), i. (1837) 22.
- Rainfall in different parts of England, the amount lost by evaporation and absorption, and the quantity flowing off the ground, vii. 275, *et seq.*
- , amount of, in London, for the years 1820 to 1829, inclusive, xiii. 113.—Table of the instances of the fall of rain amounting to more than half an inch within twenty-four hours, during the years 1851-52-53, 115.
- and spontaneous evaporation at Melbourne, Geelong, Yan-Yean, and Ballarat, during the years 1855-56-57, xviii. 382, *et seq.*
- during the year 1858, at different places upon and near the western coast of India, xix. 601.
- and percolation, tables of, through Dalton's gauges, filled with surface soil and chalk, at Nash mills, Hertfordshire, from October 1833 to December 1860, xx. 222.
- at Aberdeen, Arbroath, and Elgin, and quantity of water flowing off the ground, xx. 324.
- Rain-gauges, experiments upon, ii. (1842) 159, 161; (1843) 159, *et seq.*—Proper position for placing, vii. 277.—Rain-gauge used at Mr. Dickinson's mill at Hemel Hempstead, xiv. 81, 86.
- Raising water, comparative merits of the single-acting engine and of the crank engine in, i. (1837) 81.
- RAMMELL, C. [Election, xiv. 374; memoir, xvi. 127.]
- Rams, steam, or vessels for running down, design and construction of, xix. 223.
- RAMSAY, G. H.
- Gas, use of clay retorts for making, xvi. 326.
- Ramsbottom's (J.) system of coal-burning in locomotive engines, on the London and North Western railway, xix. 553.
- RAMSDEN, J. [Election, xvi. 46.]
- RANKINE, Lieutenant D.
- Railway carriages, his spring contractor for (Rankine, W. J. M.); ii. (1843) 111.
- RANKINE, W. J. M. [Election, ii. (1843),

RANSOME.

- 105; Walker premium, iii. 7; Telford premium, viii. 6; resignation, xvii. 85.]
- Air engines. Extracts from paper by him "On the means of realizing the advantages of the air engine" (Crispe, G.), xii. 331.
- Caisson, sliding, at Keyham dock-yard, xiii. 459.
- Marine engines. Consumption of fuel per I. H. P. per hour, particularly in the engine of the 'Thetis,' by Messrs. Rowan & Co., xviii. 274.
- Railway axles. "On the causes of the unexpected breakage of the journals of railway axles; and on the means of preventing such accidents by observing the law of continuity in their construction," ii. (1843) 105.
- Causes of the unexpected breakage of the journals of railway axles, xiii. 467.
- Railway carriages. "Description of Lieutenant D. Rankine's spring contractor," ii. (1843) 111.
- Railway curves. "Description of a method of laying down railway curves on the ground," ii. (1843) 108.
- Railway inclines. "Description of a safety-drag, or apparatus for preventing accidents to trains ascending inclined planes, used on the Edinburgh and Dalkeith railway since 1832," iii. 284.
- Sea-defences. "Account of the effect of the storm of the 6th of December, 1847, on four sea-walls, or bulwarks, of different forms, on the coast near Edinburgh; as illustrating the principles of the construction of sea-defences," vii. 186.—Remarks, 199.
- RANSOME, F. [Election, vii. 184; Telford medal, viii. 6.]
- Stone, artificial. "On the manufacture of artificial stone, with a silica base," vii. 57.—Remarks, 59.—Its comparison with terra-cotta, 64, 65.—Power of the artificial stone to resist pressure, 68.
- RANSOME, J. [Election, ii. (1842) 122; memoir, x. 99.]
- RANSOME, J. A. [Election, v. 248; Member of Council, xviii. 164.]

RAWLINSON.

- Astronomical instruments, means for insuring accuracy in the construction of the large, for the Royal Observatory, xvii. 194.
- Cattle-market, establishment of a, outside the metropolis, viii. 78.
- Iron, cast, uncertainty in the strength of, xviii. 358.
- Machinery for operating on wood, particularly the pendulum saw, and the railway key and trenail machinery, xvii. 42.
- Permanent way. Use of compressed fastenings on railways in India, xviii. 424.
- RANSOME, R. [Election, i. (1841) 83.]
- Iron, quality of Scotch hot blast, ii. (1843) 132.
- RANSOME, R. T.
- Stone, artificial. Production of architectural ornaments, and other works of art, in artificial stone, made with a silica base, vii. 65.
- Ransome and May's compressed wedges and trenails, xi. 256.
- railway key and trenail machinery, cross-cut saw used in, xvii. 24, 32, 42, *et seq.*
- Ransome's and Biddell's solid chilled cross-ing, xvi. 299.
- RANSON, R. G. [Election, ii. (1842) 122; memoir, iii. 15.]
- RASTICK, J. U. [Memoir, xvi. 128.]
- Permanent way. M. D'Harcourt's artificial granite for railway blocks, i. (1839) 59.
- RATHBONE, T. W.
- Decimal coinage, xiii. 337.
- RAVENHILL, R. [Election, i. (1840) 31; Auditor, ii. (1842) 51; (1843) 67.]
- RAWLINSON, R. [Election, vii. 184; Council premium, xiii. 127.]
- Canals. Attempts to make canals compete with railways, xiii. 211.—Navigating vessels on canals by means of screw propulsion, 212.
- Docks, Southampton, construction of, and building of dock-walls generally, particularly the dimensions and cost of the Liverpool dock-walls, xvii. 552.
- Construction of dock-gates of large

RAWLINSON.

- span, xviii. 481.—Culvert behind the gates at the Liverpool docks, and as to pile-driving, 512.
- Drainage of land, evaporation and rainfall, xx. 218.
- Drainage of towns. "On the drainage of towns," xii. 25.—Remarks, 41.—Drainage of the town of Hitchin, 41.—Use of pipe sewers at Manchester, 42.—Ditto in Back King-street, Bury, 42.—Failures of pipe sewers at Croydon, 43.—Circumstances determining the adoption of brick sewers, or pipe drains, 45.—Size, thickness, and materials of pipes, 55.—Use of pipe drains at Durham, 58.—Applicability of pipe sewers, under certain circumstances and in suitable localities, 100.—Necessity for manholes, and lampholes on lines of pipe sewers, 103.—Ditto means of flushing at each manhole, 103.
- Irrigation with sewage water of the Craigentenny meadows, near Edinburgh, xx. 236.—Pollution of rivers by the discharge of sewage into them, 237.—Stanley Green liquid sewage works, 246.
- Harbours of refuge on the east coast of England, xx. 360.
- Masonry, rubble, particularly that at the Liverpool docks, xvi. 436.
- Naval construction, &c. Use of yellow pine for the decks of steamers above the boilers, xviii. 437.
- North Sea, xx. 360.
- Water, flow of, formulæ for determining, through pipes, xiv. 304.—Experiments made by the General Board of Health, 313, 314.
- Water mains, joints of, xiv. 40.
- Water meters, and necessity for their use for every purpose of trade, xvi. 63.
- Water supply. Depths at which it is necessary to sink for water, xiv. 92.—Yield from water-bearing strata, the depth at which water is to be obtained, and the caution which should be exercised in relying, for large communities, upon a supply of water from wells, xix. 49.—Sinking wells near the sea coast, and as to that at Worthing

REDMAN.

- 50.—Fountains in Trafalgar-square, 51.
- Water-works, Melbourne gravitation, form and mode of constructing embankments for reservoirs, and as to outlet-pipes, or culverts, being placed in the solid, by tunnelling, or side-trenching, and not through the 'made' earth, xviii. 391.—Works for conducting and storing water in Eastern countries, particularly the supply of Constantinople, 393.—Dependence being placed on the minimum rainfall, and not on the average of a number of years' observation, 394.—Distributing apparatus within towns, and use of water, 395.—Graduating the mains for conducting water into towns, and Liverpool waterworks, particularly the size of the main, 396.—As to making an embankment with wet materials, 396.
- RAWNSLEY, H. [Election, i. (1840) 41; memoir, xii. 168.]
- Receipts and Expenditure. *Vide* ACCOUNTS.
- RECLAIMING LAND FROM THE SEA.
- "On reclaiming land from the sea, with plans illustrative of works in Loughs Swilly and Foyle." By J. W. Bazalgette, i. (1840) 41.
- Reclaiming land from the sea by polders (Jackson, G. B. W.), vi. 95, *et seq.* *Vide* also CANALS, Great North Holland.
- REDFIELD, W. C.
- Steam boilers, explosions of, quotation from opinion of, (Woodcock, W.), xv. 291.
- REDMAN, J. B. [Election, i. (1839) 44; Telford medal and premium, i. (1840) 8; premium, v. 2; Telford premium, viii. 6; Council premium, xii. 116.]
- Bridges. "An account of the new stone bridge over the river Lee, at Stratford-le-Bow," i. (1839) 77.
- Coal trade of the Port of London, showing the gradual development of the sea-borne tonnage up to 1850, and since that year the increase in the amount brought up by railway, xvii. 408.
- Coasts, &c. "On the alluvial formations, and the local changes, of the South Coast of England," xi. 162.—Remarks,

REDMAN.

- 205.—Movement of shingle, 206.—
Meeting of tides in the channel, 222.—
Chesil Bank, 222.
- Docks. "On the formation of entrances
to wet and dry docks, situated upon a
tideway; illustrated by the principal
examples in the Port of London," vii.
159.—Remarks, 173.—West India, the
London, and the St. Katharine's docks,
and best angle for a wall along which
a vessel has to pass to enter a lock,
173, 182.—Ipswich docks, 179.—Pro-
posed wet dock, 183.
- Dock accommodation at the out-
ports, xv. 215.
- Harbours of refuge, various projects pro-
posed for, along the coast from the
Thames to Sheerness, and from thence
to Portland, xviii. 131.
- Lighthouses. "Description of the Maplin
Sand lighthouse, at the mouth of the
river Thames," ii. (1842) 150; vii. 146.
- Marine worms. Ravages of the, 'tere-
brans,' in brackish water, vi. 55.
- Piers. "Account of the new cast-iron
pier, at Milton-on-Thames, next
Gravesend, in the county of Kent; with
details of the mode of construction
adopted in its erection," iv. 222.—
Remarks, 246.—Cast-iron girders of
ditto, 246, 247.—Foundations of ditto,
248.
- River Clyde, progressive improvements
in, and notice of the reports of various
engineers, v. 333.—Importance of the
tidal scour, 336.—Expediency of open-
ing a new south channel for the navi-
gation, 336.
- Orwell. Depositing material exca-
vated from the artificial channels, in a
crooked reach of the natural channel,
xx. 18.
- Thames. Embankments of the
lower reaches, xv. 210.—Rise, and great
range, of tide, 211.—Variations in the
tides, 212.—Successive formation of
wet docks, 213.—Steady increase in
the foreign imports into, and exports
from, the Port of London, 215.—In-
creasing wants of dock acreage in the
Port of London, 215.—Wharf and tidal

RENDEL.

- docks at East Greenwich, and repairs
of pier at West Greenwich, 216.—
Accommodation for embarking and
disembarking steamboat passengers,
216.—Undertakings necessary for its
improvement, 242.
- Roads. Macadamizing of the Com-
mercial road, xiii. 240.
- Sea defences. 'Arming' at the Dym-
church wall, vi. 123, 131.—Survey
of the Dymchurch wall, 481.—Wall at
the mouth of the river Medway, 482.—
Sea defences in general, 482.—Groynes
at Sunderland, and power of the groynes
on the southern coast of England, in
accumulating shingle, viii. 206.
- Tides. Propagation of the tidal wave
around the seaboard of Great Britain,
xx. 356.
- Timber, specimens of, affected by the
pipe-worm 'Teredo navalis,' iv. 77.
- REED, R. F. [Election, xiv. 374.]
- REED, S. [Election, i. (1839) 42.]
- REED, W. [Election, i. (1840) 26.]
- REEVE, L.
Marine worms. Modes of action of
'pholades' and 'teredines,' ix. 49.
- Reflectors for lights, silvered porcelain, Hon.
Major Fitzmaurice's, xv. 24.
- Refrigerator composed of a series of oval
copper pipes, defects in the soldered
joints of a, causes of the, xiii. 464.
- Regenerative engines, results obtained by
Mr. C. W. Siemens, from his, xvi. 15.
- Regnier's improvements in letter, or puzzle
locks, xiii. 253.
- REICHENBACH, M. DE.
Hydraulic engines. Water-pressure en-
gine at Illsang, ii. (1842) 55.
- REID, Colonel Sir W., R.E. [Resignation,
xi. 93.]
- REID, J. [Election, iii. 284.]
- REID, J. [Election, xviii. 231.]
- REID, W. [Election, xiii. 475.]
- Electric telegraph. Experiments in
transmitting messages from Dover to
France, xi. 379.
- REMINGTON, G. [Election, ix. 303.]
- RENDEL, A. M.
Docks. Failures in the walls of the
Great Float at Birkenhead, xviii. 506.

RENDEL.

Marine worms attacking the creosoted timber of Leith Pier, xviii. 437.

Permanent way. Creosoted sleepers used on the East Indian railway, xviii. 437.

RENDEL, J. M. [Telford medal, i. (1838) 8; (1839) 10; Member of Council, (1840) 36; (1841) 52; ii. (1842) 51; (1843) 67; iii. 66; Vice President, iv. 62; v. 142; vi. 46; vii. 56; viii. 44; ix. 91; x. 60; President, xi. 84; xii. 112; memoir, xvi. 133.]

Address on taking the chair for the first time after his election as President, xi. 148.—Great Exhibition, 149.—The occupation of the Civil Engineer, 150.—Result of the railway system, 151.—Great Northern railway, 151.—Prolongation of South Wales line, 151.—Ulverstone and Lancaster railway, 152.—Royal Border bridge, 152.—Tubular bridge across the Menai Straits, 152.—New bridge at Rochester, 152.—Irish railways, 152.—Viaduct, near Newry, 152.—Colonial railways, 153.—Indian railways, 153.—Railway in Egypt, 154.—Continental railways, 154.—Railway system in United States of America, 155.—Railway across the Isthmus of Panamá, 156.—Electric Telegraph Company, 156.—Principal marine works in progress, 156.—Harwich breakwater, 157.—Portland breakwater, 157.—Holyhead harbour, 157.—Lowestoft harbour, 157.—Steam navigation, 158.—Improvement of rivers, 158.—Reclaiming land, 159.—Water supply of cities and towns, 159.—Iron ore near Middlesbrough-on-Tees, 160.—Ditto near Northampton, 161.

—, on vacating the chair, xiii. 185.

Blasting under water. Tamping, i. (1838) 34.

Boats. Iron canal-boats, ii. (1843) 178.

Breakwater, Plymouth, i. (1841) 162.—

Accuracy of his estimate of the vacuity in the Plymouth breakwater, vii. 409.

—Harwich breakwater, xi. 157.—Portland breakwater, 157.

Bridges. Construction of suspension

RENDEL.

bridges, i. (1841) 79.—Timber bridges for railways, 90.

Bridges. "Memoir of the Montrose suspension bridge," i. (1841) 122.—Remarks, 127.—Construction of the platforms of suspension bridges, for avoiding the injurious action of the wind, 127.—Adaptation of suspension bridges to railways, 128.—Trial suspension bridge over the river Tees, 129.

— Proper sites for suspension bridges, iv. 293.—Failures of the Montrose suspension bridge, 294.—Construction of suspension bridges, more particularly the platform, 294.—State of the chains of the Montrose suspension bridge when taken down, 295.—Proposal for spanning the Menai straits, for the Chester and Holyhead railway, 295.—Yarmouth suspension bridge, 295.—Hungerford suspension bridge, 296.—Modes and cost of founding the piers of bridges in rivers, x. 366, 367, 369.—Bridges on Warren's principle, intended for railways in India, xi. 14.—Royal Border bridge, 152.—Tubular bridge across the Menai Straits, 152.—New bridge at Rochester, 152.

Canals. Perpendicular lifts on the Great Western canal, xiii. 210.—Experiments by Sir J. Macneill, on towing canal-boats by a locomotive engine, 212.

Cements, xi. 510.

Civil engineer, occupation of the, xi. 150.

Coasts, &c. Formation of shingle-banks, xi. 222.—Depth at which shingle travels, 223.—Travel of shingle off the coast of Lyme, 223.—Desirability of observations on the coast, xii. 557.

Coffer-dam at Great Grimsby, ix. 9, 20.—Cost of ditto, 12.

Docks entrances, vii. 181.—Reasons for the selection of the site of the new docks at Great Grimsby, ix. 12.—Intended works at Grimsby, 13.—Sluicing, or scouring the entrance to harbours and docks, and system adopted at Sunderland, xv. 449.

Drainage of towns, xi. 421; xii. 106.—Choice of materials for construction of

RENDEL.

- sewers, 108.—General question of sanitary reform, 108.—Drainage of the district south of the Thames, xiii. 78, 100.—Sewerage by natural gravitation, or by artificial means of pumping, 83.
- Dredging, cost of, x. 293.
- Electric telegraph company, xi. 156.
- Exhibition in 1851, xi. 149.
- Ferries. "On the floating bridge across the Hamoaze, from Devonport to Torpoint," i. (1838) 21.—Remarks, 24.
- Floating bridges introduced by him at Portsmouth and at Torpoint (Greaves, C.), xx. 886.
- Fire-arms. Manufacture of Colt's revolvers by machinery, xi. 59.
- Fire-proof buildings, especially in reference to the question of insurance, viii. 160.—Construction of, xii. 271.
- Foundations. Desirability of ascertaining what weight different kinds of foundations, whether artificial, or natural, will bear, x. 241.
- Geology. Advantage of a knowledge of geology to engineers, ix. 16.—Mode of testing the capabilities of soils, 17.—Clay at the Leith docks, 20.
- Girders, Warren, xii. 611.
- Harbours. Holyhead, xi. 157.—Lowestoft, 157.
- India rubber, application of vulcanized, and gutta percha to engineering purposes, xii. 459.
- Iron, improvement in the quality of, xii. 381.
- Iron ore near Middlesbro'-on-Tees, xi. 160.—Ditto near Northampton, 161.
- Lock-gates, iron, for the docks at Sevas-topol, vi. 54.
- Marine works in progress, xi. 156.
- Marine worms. Ravages of the 'teredo' and 'terebrana,' vi. 54, 55.
- Masonry. Comparative value of ashlar and rubble work, x. 239.
- Motive power, use of heated air as a, xii. 351.
- Piles, driving, iii. 200, 209.
- Railway accidents, xi. 477.
- Railway, atmospheric. System of atmospheric propulsion for a railway, in

RENDEL.

- which water-power was to be used for exhausting the tube, iv. 290.
- Railway system, result of the, xi. 151.—Railway system in United States of America, 155.
- Railways. Great Northern railway, xi. 151.—Prolongation of South Wales line, 151.—Ulverstone and Lancaster railway, 152.—Irish railways, 152.—Colonial railways, 153.—Indian railways, 153.—Railway in Egypt, 154.—Continental railways, 154.—Railway across the Isthmus of Panamá, 156.
- Reclaiming land, xi. 159.
- Rivers and estuaries. Possible effect of the improvements in the river Severn, iv. 113.—Question where artificial navigation should begin and natural navigation end, x. 292.—Improvement of rivers, xi. 158.—Treatment of rivers, xii. 22.—Report, of 1849, on the best means of improving the navigation of the river Lee, referred to (Beardmore, N.), xiii. 243.—Effect upon the sanitary condition of the metropolis, and upon the navigation of the river, above and below London bridge, of the construction of proposed chain of locks at that point, xv. 240.
- Sea walls, and comparison of those on the coast near Edinburgh, and on the coast of Devonshire, vii. 196.—Difficulty of protecting the toe of the wall, 195.
- Ships and steam vessels. Mallet's proposed method of raising ships, ii. (1842) 136.—Measurement of ships for tonnage, xiii. 32.—Probable advantages and disadvantages of large steamers, with respect to their scientific construction, their capabilities for navigation, and their commercial economy, 32.—Increase in the dimensions of vessels, and necessity for adopting dimensions for docks and harbours to accommodate them, 60.
- Sluice, Ohelson meadow (Budd, T.), ii. (1842) 62.
- Steam, percussive force of, i. (1840) 79.
- Steam navigation, xi. 158.
- Stone, artificial, employment of, in works of construction, vii. 68.

RENNIE.

Timber. Experiments made at Southampton, to test the value of the different processes for protecting timber from the ravages of the worm, ix. 53; xii. 242.—Greenheart timber and 'Jarrah' wood, xii. 233.—Preservation of timber from the worm, 242.

Viaducts. Viaduct near Newry, xi. 152.—Wrought-iron structures, 240.

Water supply of cities and towns, xi. 159.—Consumption of water at Edinburgh, xii. 505.—Quantity of water obtained from well at Great Grimsby, 505.

Waves, depth to which the action of extends, vii. 198.

RENNIE, G. [Election, i. (1841) 129; Member of Council, ii. (1842) 51; (1843) 67; iii. 66; Telford medal, xvii. 80.]

Air engines. Trials of Sir G. Cayley's hot-air engine, xii. 345.

Aqueducts. "Description of the bridge-aqueduct of Roquefavour, on the line of the canal of Marseilles," xiv. 190.—Remarks, 204.—Ancient Greek aqueduct at Patara, 206.

—"Description of the Pont du Gard," xiv. 236.

Arches. "On the expansion of arches," i. (1840) 4.

—, iii. 107.—Experiments upon elliptical cast-iron arches, xviii. 356.

Beams. Mode of spanning large areas in mills, and objections to the combination of wrought and cast iron in beams, vi. 222.

Breakwaters, ii. (1842) 126.—Forms and construction of breakwaters, xviii. 101, 133.—Report, by Herr Von Hagen, on the breakwaters at Bouc, Cassis, Cotte, Ciotat, Agde, and Vendres, 133.—Port of Marseilles, 134.—Force of the waves upon vertical structures, 135.

Bridges. Oblique bridges, iii. 60.—'Wellington' bridge, Leeds, 107.—Bridge of the Boverie (Liège), 111.—Effects of increased velocity on bridges, ix. 270.—Bowstring form of bridge, 270.

Canals. Horse-power, and force of traction of the boats on the Grand Junc-

RENNIE.

tion Canal, ii. (1843) 115.—Canal of Terneuse, vi. 113.—Description of the course, 114.—Principal dimensions, 114.—Gates and other works, 114.

Chesil Bank, xi. 207; xii. 552.

Coasts, &c. Action of the sea on banks, such as the Chesil Bank, and translation of shingle, vii. 361.—Formation of Dungeness Point and Romney Marsh, xi. 220.

Concrete and rubble masonry. "On the employment of rubble béton, or concrete, in works of engineering and architecture," xvi. 423.—Remarks, 436.—Pont de l'Alma, built of rubble and Vass cement, and its cost, 436.

Docks. Situation chosen for the docks at Sevastopol, vi. 53.—Construction of the iron lock-gates, 53.—Means of letting off water from inner basins, 54.—Dock entrances, vii. 175.—New docks at Sunderland, and sea defences generally, viii. 201.

Fluids, experiments on the resistance of, v. 273.—Summary of Colonel Beaufoy's ditto, 274.—His communication to the Royal Society, "On the resistances of solid bodies in air and water," with the conclusions arrived at, 274.

Friction. Influence of unguents on the general laws of friction (Pole, W.), ii. (1843) 77.—Friction independent of the rubbing surfaces 79.

Iron, strength of, made with anthracite, ii. (1843) 130.—Experiments on the ultimate strength of bars of Blaenavon cast iron, of different depths and thickness, the sectional area and other dimensions being the same, xviii. 356.—Increase of strength obtained by an admixture of wrought iron with cast iron, as proposed by the late Mr. Morris Stirling, 357.

Locomotive engines, construction of, particularly the distribution of the weights on the wheels, placing the driving-wheels behind the fire-box, and lowering the centre of gravity, viii. 244.

Piles, driving, iii. 201.

Railway trains, resistances to, experiments

RENNIE.

- instituted by the British Association for ascertaining, v. 419.
- Scaffolding, iii. 207.
- Screw piles, vii. 141.
- Screw propellers. "On the dimensions and performances of an Archimedean steamer," i. (1839) 70.
- , iii. 72, 76.—Effects of the application of the screw propeller, vi. 292.
- Sea-walls at Penmaen Mawr, Venice, Ostend, and Malta, x. 276.
- Ships and steam vessels. Earliest machine for proving cables, and form of the links of chain-cables, xvi. 307.—Actual speeds of the 'Candia' and the 'Pera,' compared with the speeds calculated from the square and cube theories, 341.—Effect of lengthening the 'Candia,' 342.
- Steam, superheated and combined, xix. 478.
- Steam navigation, &c. Employment of high-pressure steam, working expansively, in marine engines, the progress of steam navigation, and the forms and proportions of boilers, viii. 307.—Best route, having regard to winds, currents, and calms, to and from the Pacific Ocean, at the different seasons of the year, and most economical mode of performing the voyages, xiii. 56.—Voyage in the 'Du Trembley' iron steam-vessel, worked by steam and ether combined, xviii. 253.
- Telegraph cables. Effects of the heavy waves of the Atlantic when paying out a telegraph cable from the stern, compared with paying it out through a hole in the middle of the vessel, xvii. 325.
- Tides, confluence of, in the channel, xi. 206.
- Turbine, ii. (1842) 100.
- Water-wheels, ii. (1843) 64.—Construction of, and of turbines, viii. 59.
- Water, supply of, to Marseilles, xiv. 205.—Mode of conveyance of water by the Romans, 205.—Employment of lead pipes by the Romans, for conveying water across and beneath bed of river, 205.—Three modes of conducting water, as described by Vitruvius, 207.

RENNIE.

- RENNIE, G. B. [Election, xvi. 309.]
- RENNIE, J.
- Ewart, P., his first apprentice (Walker, J.), ii. (1843) 25.
- Harbours. Suggestions for altering Sunderland harbour (Murray, J.), iii. 343.
- Piles. Application of steam-power to drive piles at the London and the Hull docks (Rennie, G.), iii. 201.
- Water-wheels. Introducer of peculiar sluice-gates for water-wheels (Rennie, G.), ii. (1843) 64.
- RENNIE, Sir J. [Election, iii. 342; President, iv. 63; v. 142; vi. 46.]
- Address, on taking the chair for the first time after his election as President, iv. 23.
- , to the annual general meeting, v. 19.—Retrospective view of the civil engineering of Great Britain, 19.—Inland navigation, 19.—Progressive improvements of the steam engine, 20.—Smeaton's principal works, 21.—Watt's improvements in the steam engine, 22.—Brindley's improvements in inland canal navigation, 23.—Summary of the most important engineering works constructed in Great Britain during the latter half of the last century, 24.—Stone bridges, 25.—Iron bridges, 28.—Suspension bridges, 31.—Wooden bridges 33.—Strength of materials, 34.—Concrete, 34.—Use of bricks for bridge work, 34.—Roman cement, 35.—Tunnels, 35.—Harbours, 37.—Revetments, or retaining walls, 41.—Drainage, 43.—Steam drainage, 48.—Machinery and manufactures, 49.—Water wheels, 52.—Water-works, 58.—Sewage, 61.—Gas, 62.—Roads, 63.—Paving, 67.—Railways, 68.—Steam coaches, 77.—Fast canal boats, 77.—Stationary engine system, 78.—Atmospheric railways, 79.—Steam navigation, 81.—Iron vessels, 96.—Screw propelling, 97.—Electric telegraph, 103.—Clocks, 105.—Mineralogy and geology, 107.—Ventilating and warming, 108.—Architecture, 109.—Agriculture, 111.—Surveying, 112.—Drawing, 113.—Meteorology, 115.—Patents, 115.—

RENNIE.

Theory and practice, 116.—Continental engineers, 117.—Prospects of civil engineers, and duties of professional men, 118.

Address, ditto, vi. 19.—Remarks on the progress of the science of engineering, 19.—Different systems of land locomotion, 20.—Steam vessels, 21.—Screw propelling, 21.—Auxiliary steam power, 21.—Bar harbours, 22.—Sewage, 23.—Artificial harbours, 24.—Machinery, 25.—Chemistry, 25.—Agriculture, 25.—Gun-cotton, 26.—Electricity, galvanism, magnetism, and light, 26.—Employment of civil engineers for Government works, 28.—Alterations of the bye-laws of the Institution, 30.—The Institution becoming the repository for all matters connected with the profession, 31.

—, ditto, vii. 27.—Remarks as to the balloting list for Members of Council, particularly the biennial change of President, and the nomination of Mr. Field for that office, 27.—Necessity for making the Institution the depository of communications, written or oral, descriptive of executed works, 28.—Public works coming under the control and cognizance of the Government, 30.

Agriculture, v. 111; vi. 25.

Architecture, v. 109.

Beams, cast-iron, proportions between the breaking weight and absolute strength, vi. 224.

Blasting under water at Newry, Howth, Portpatrick, and Donaghadee harbours, iv. 371.—Application of gun-cotton to blasting, vi. 26.

Breakwaters. Plymouth, vii. 402, 414.—Cherbourg, 408.—'Pierre-perdue' system of constructing, and the cost, illustrated by piers at Kingstown and Howth, and breakwater at Plymouth, xviii. 117.—Construction of artificial blocks of *béton*, and their use at the new port at Marseilles, contrasted with the cost of the rubble-stone breakwater in Plymouth Sound, 132.

Bricks, use of, for bridge-work, v. 34.

Bridges, stone, v. 25.—Iron, 28.—Suspension, 31.—Wooden, 33.

RENNIE.

Canals. Action of the London clay on the old Croydon canal, iv. 85.—Introduction of pound-locks, and ancient method of navigating rivers, 111, 113.—Brindley's improvements in inland canal navigation, v. 23.—Fast canal boats, 77.—Canals and rivers of Holland, vi. 120.—Great North Holland canal, 121.—Means of draining the neighbourhood, 121.—Construction of the sea-lock at Corpach, on the Caledonian canal, xiv. 39.

Cement, Roman, v. 35.

Chemistry, vi. 25.

Civil and mechanical engineers. Continental engineers, v. 117.—Prospects of civil engineers, and the duties of professional men, 118.—Employment of civil engineers for Government works, vi. 28.

Civil engineering of Great Britain, retrospective view of, v. 19.—Theory and practice, 116.—Progress of the science, vi. 19.

Clocks, v. 105.

Coffer-dams for building the great wall of the Dockyard at Sheerness, vi. 159.—At new docks at Sunderland, xiv. 39.

Concrete, v. 34.

Cranes used in the erection of the Bell Rock lighthouse, iv. 345.

Diving bell, means of applying the, to hydraulic constructions, v. 248.

Dock gates, Sevastopol, reasons for constructing them of iron, vi. 54.

Drainage of land. "An account of the drainage of the level of Ancholme, Lincolnshire," iv. 186.—Remarks, 200.—Leading principles of drainage, 200.—Defects of the Bedford level, 200.—Works of the Nene outfall, 201.—Peculiar features of the Ancholme drainage, 209.—Middle level, 209.—Drainage works of Mr. Telford, 211.—Outfall below Boston, 211.

—, v. 43.—Steam drainage, 48.—Difficulties in carrying out measures for arterial drainage, xix. 90.—History of the drainage of the fens, called the Bedford level, 91.—Main principles of drainage and navigation, 98.

RENNIE.

- Drainage of towns. Sewage, v. 61; vi. 23.—Proposed intercepting sewers for the drainage of the metropolis, xv. 230.
- Drawing, v. 113.
- Dredging, cost of, x. 293.
- Electric telegraph, v. 103.
- Electricity, galvanism, magnetism, and light, vi. 26.
- Embankment, Nene, vi. 122.
- Engineering works, summary of the most important, constructed in Great Britain during the latter half of the last century, v. 24.
- Ferries. Want of analogy between the steam-ferry over the river Nile, and the floating-bridges introduced by the late Mr. Rendel, xvii. 64.
- Foundations, formation of artificial, under water, iv. 248.—For the basin at the Royal Dockyard, Deptford, vi. 153.
- Gas, v. 62.
- Geology and mineralogy, v. 107.
- Goodwin sands, iv. 321.
- Harbour, Sunderland, suggestions relative to (Murray, J.), iii. 343.
- "On the ancient harbour of Ostia," iv. 307.—Remarks, 321, 322.—Formation of deltas, shoals, and bars at the entrances of harbours, 321.—Goodwin sands, 321.—Dover harbour, 322.—Italian harbours, 322.
- Harbours, v. 37.—Bars, vi. 22.—Artificial, 24.—Kingstown, Howth, Ardglass, Portrush, and Dunmore, vii. 405.—Construction of, in a travelling beach, xii. 549.—Harbour of Blyth, xviii. 116.
- Harbours of refuge, contemplated sites for, and modes of construction, vii. 402.—Proposed in Dover Bay, 408.
- Inland navigation, v. 19.
- Iron, cast, change produced by sea-water in, iv. 333.
- Lighthouses, forms of foundations for, vi. 148.—Proposed cast-iron lighthouse for the Bell Rock, ix. 189.
- Lock-gates, use of iron for, xviii. 520.
- Locomotive engines. Different systems of land locomotion, vi. 20.
- Machinery and manufactures, v. 49.—Machinery, vi. 25.

RENNIE.

- Masonry. Practice of the late Mr. Rennie, to avoid mixing ashlar and rubble in same work, x. 235.
- Materials, strength of, v. 34.
- Meteorology, v. 115.
- Naval construction, &c. First introduction of iron for steam vessels, iv. 180.
- Patents, v. 115.
- Paving, v. 67.
- Piers. Principles which should regulate the construction of hydraulic works, vi. 146.—Construction of north and south piers of new harbour of Whitehaven, 146.—Jetties and groynes, 148.
- Pipes. Floating out and laying a main of pipes in the bed of a river, xiv. 40.—Trial of bored stone pipes for water-mains, 40.
- Portrait of, by J. Andrews, xi. 111.
- Public works coming under the control and cognizance of Government, vii. 30.
- Railway, atmospheric, v. 79.
- Railway trains, resistances to, letter from Mr. D. Gooch, v. 415.—Proposed experiments on the Epsom line (atmospheric) for determining, 482.
- Railways, v. 68.—Stationary-engine system, 78.
- Reclamation of lands. System of warping, vi. 121.—Method of constructing the dykes round the polders, 121.
- Retaining walls, or revetments, v. 41.
- Roads, v. 63.
- Rivers and canals. "On the improvement of the navigation of the river Newry," x. 277.—Remarks, 290.—Limits within which it is advisable to attempt improvements in a river, and beyond which a canal should be adopted; illustrated in the cases of the Clyde and the Newry, 290, 292.
- Rivers and estuaries. Desirability of having communications relative to the present state of important rivers, and their capability of improvement, v. 314.—Necessity for their gradual improvement, 331.—River Wear, and Sunderland harbour, vi. 280.—Mode of testing the deposits in the river Wear, 283.—Past and present condition of the Thames, xv. 221.—Probable effect of

RENNY.

- the Tyne docks upon the tide of that river, xviii. 520.—Italian and Indian rivers, and value of works of irrigation, xix. 98.—Improvements in the Ouse, 101.—Alteration in the high-water level in the Thames by the removal of Old London bridge, 112.—Effects on the condition of rivers, of the arterial drainage of large towns, and the under-drainage of land, xx. 212.—Ditto of town drainage and sewage, 232.
- Screw propellers, iv. 170; v. 97; vi. 21.—Use of, as an auxiliary steam power, 21
- Sea defences, construction of, vi. 122, 128.
- Great Mole at Venice, 128.
- Shingle, movement of, xii. 549.
- Ships and steam vessels. Iron vessels, v. 96.—Steam vessels, vi. 21.
- Smeaton's principal works, v. 21.
- Steam coaches, v. 77.
- Steam engine, progressive improvements in the, v. 20.—Watt's improvements, 22.—Nominal horse power, x. 310.
- Steam navigation, v. 81.
- Surveying, v. 112.
- Tides. Rise of the tide in the Humber, at Ferraby sluice, iv. 202.—Tidal observations made by Mr. Giles, on the Tyne and the Wear, between the years 1815 and 1818, v. 311.—General datum line for ditto, throughout England, 311.
- Tunnels, v. 35.
- Warming and ventilating, v. 108.
- Water-wheels, v. 52.
- Waterworks, v. 58.
- Waves, effect of, striking vertical walls, vi. 130.
- RENNY, H. L. [Election, ii. (1843) 183.]
- RENNY, Lieutenant W. L. [Resignation, xiv. 108.]
- RENTON, H. [Telford medal, i. (1841) 9; memoir, xi. 105.]
- River Ouse. "On the improvement of navigable rivers, with a description of a self-acting wasteboard at Naburn lock, on the river Ouse," i. (1840) 26.
- Renwick's patent for preserving timber with coal oil, ii. (1842) 68.
- Repeating fire-arms, xi. 31.
- Reports, annual, of Council. *Vide* ANNUAL REPORTS OF COUNCIL.

RESERVOIRS.

Reservoir, cast-iron, for the Glasgow water-works (Maackain, D.), ii. (1843) 139.

RESERVOIRS.

Bann. "Description of the Bann reservoirs, County Down, Ireland." By J. F. Bateman, i. (1841) 168.—The act of Parliament for, 168.—Construction of the embankment, 169.—The discharge pipes, 170.—Details of some experiments on cements, 170.

—"Description of the Bann reservoirs, County Down, Ireland." By J. F. Bateman, vii. 251.—Character of the Mourne Mountains, in which the river Bann rises, 251.—Liability to devastating floods, rendering remedial measures necessary, 252.—Principle of the Act, obtained in 1836, for the construction of the reservoirs, and for regulating the manner in which the money was to be raised, and the rates to be levied, 252.—Projected impounding reservoirs at Lough Island Reavy and at Deer's Meadow, and auxiliary reservoir at Corbet Lough, 253.—Detailed description of the formation of the reservoir at Lough Island Reavy, 254.—Shallow lake selected as the site, 254.—Field of fossil conifers in the bottom of the lake, 254.—Difficulty in determining the proper extent of the reservoir, 255.—Details of the mode of construction of four embankments for retaining the water in the lake, or reservoir, above its summer level, 255.—Culvert under the principal embankment for discharging the water, 257.—Mortar prepared from the mountain limestone from the Isle of Man, 258.—Leaks in the outer culvert attributed to the rubble backing behind the side walls, which had been substituted, without authority, for the puddle prescribed in the specification, 259.—Mode in which the leaks were stopped, 260.—Masonry of the fore-bay of the discharging-chamber, 260.—Discharge pipes and valves, 261.—Waste weir for discharging the surplus water, 261.—Bridge across the feeder from the river Mud-

RESIN FUEL.

dock, 262.—Diversion of the river Muddock, and construction of the Moneyscalp and Slievenalargy feeders, to bring the requisite supply of water to the reservoir, 263.—Cost of the works, 264.—Particulars and calculations of the amount of rain, and the available supply, 264.—Rain-gauge observations at Lough Island Reavy, and on Spelga, 265.—Account of the manner in which it is proposed to work the Corbet Lough reservoir in connection with that at Lough Island Reavy, 266.—Objects of the Corbet Lough reservoir, 268.—Detailed description of the works for the formation of ditto, 268.—Advantages gained by its construction, and effect upon the regular power of the river, 269.—Watercourse to convey the water of the river to the reservoir, 271.—Side-weir for withdrawing the water from the river, 271.—Stop-gates for regulating the flow down the watercourse, 271.—Bridges across the watercourse, 272.—Details of the embankment of the reservoir, 272.—Discharge-slucices and discharging-apparatus, 272.—Self-acting flood-gates, 272.—Waste-weir, 273.—Watercourse for conveying the water from the reservoir, 273.—Cost of the works, 274.

Discussion.—Bateman, J. F., 274, 275, 277, 284, 287.—Beardmore, N., 285.—Bidder, G. P., 284.—Glynn, J., 275.—Hawksley, T., 275, 282, 287.—Homer-sham, S. C., 274, 276, 280, 282, 284, 286.—Malcolm, Sir C., 282.—McCleery, —, 287.—Murray, J., 277.—Pole, W., 281.—Walker, J., 281, 286.

Coradino tank, Malta (Arrowsmith, W. L.), ii. (1843) 140.

Vide also EMBANKMENTS, and WATER-WORKS.

Resin fuel, i. (1839) 84, 87.

—, on the properties and composition of, (Williams, C. W.), i. (1839) 88.

Resin gas, v. 63.

Resistances to bodies moving through water, xvi. 381, *et seq.*

RICARDO.

Resistances to railway trains, at different velocities (Gooch, D.), vii. 292.

— on steep gradients and sharp curves, xviii. 58, 63, *et seq.*

Respiration, influence of carbonic acid and other products of combustion upon, ii. (1843) 184.—Ventilation essential for, 185, 188.—Action of carbonic acid in, 190, 191.

Retaining walls, on the filling-in behind, (Hartley, J. B.), i. (1838) 143.

— London and Birmingham railway. Euston cutting, iii. 145, 357; iv. 81, *et seq.*

—, construction of, iii. 356, *et seq.*; iv. 85; v. 41.

RETORTILLO, A. [Election, xvii. 410.]

Retorts for gas-making, on the results of the use of clay, (Church, J.), xvi. 309.

RETTIE, —.

Liquid hydrocarbons. Objections to camphine and all spirit-lamps, viii. 231.

Revolvers. *Vide FIRE ARMS.*

Reynold's inverted troughs of cast iron lined with wood for permanent way of railways, xi. 252; xvi. 245.

REYNOLDS, J. [Memoir, vii. 12.]

Railways. "On the construction of railways of continuous bearing," i. (1837) 22.

Rhine. works on the, vi. 103.

RHODES, T.

Bridges. "Description of a bridge across the river Shannon, at Portumna," iii. 99.

Weirs. Extract from a letter from him, on the effect of the oblique weirs on the river Shannon (Grantham, R. B.), v. 361.

Rhynland (Holland), account of, ii. (1842) 172.

RICARDO, J. L.

Electric telegraph, and employment of boys from Orphan Asylum to work instruments, xi. 377.

RICARDO, M.

Railways. Experiments for ascertaining the tractive force on railways, and description of the dynamometer employed for that purpose, v. 297.—Resistance of the atmosphere, 298.

RICHARDS.

RICHARDS, A. B.

Fire-arms. Colt's revolvers, and their precision in firing, xi. 55.—Deane, Adams, and Deane's revolver, 57.—Experiments with fire-arms at Woolwich, 10th September, 1851, 58.

RICHARDS, J. [Election, i. (1838) 46; Telford medal, i. (1839) 9.]

Machinery. "Description of the machinery, and of the several processes for converting refined metal into malleable finished iron, at the Rhymney works," i. (1839) 49.

RICHARDS, W. [Election, v. 438; resignation, xiii. 134.]

Richards' and Croll's gas-meter, iv. 217.

RICHARDSON, J. [Telford medal and Council premium, vii. 2; Council premium, ix. 95; xiii. 127.]

Coal. "The coal-field and the coal of South Wales," viii. 82.

Coal mines. "On the explosion of fire-damp which occurred in the Eagles-bush, or Eakyn colliery, near Neath, South Wales, on the 29th of March, 1848," viii. 118.

— Employment of water-pressure engines in, ix. 382, 385.

Mines. "On the ventilation of mines," vi. 160.

— "On the pneumatics of mines," xii. 272.

RICHARDSON, R. [Election, i. (1840) 87; Walker premium, ii. (1843) 7.]

Docks. "Description of the Port of London, and of the works at the London docks," ii. (1842) 59.

Permanent way. Invention of the fish-joint for rails, xvi. 278.

RICHARDSON, S.

Decimal coinage, plan of, proposed by him (Simpson, J.), xiii. 348.

RICHMOND, J.

Engine counter on an improved principle, vii. 71.

Richmond (Surrey), an account of the drainage of, under the authority of the Metropolitan Commissioners of Sewers, in 1851, xi. 407.

RICKARDS, J. L. [Election, xix. 268.]

RICKMAN, J. [Memoir, i. (1841) 15.]

RITTERBANDT.

RICKMAN, W. [Election, i. (1838) 34.]

Landslips. "Earthfalls at the Undercliff, in the Isle of Wight," i. (1840) 35.

RIDDELL, Captain C. J. B., R.A. [Election, iii. 342; resignation, xvi. 98.]

Fire-arms. Colt's revolvers, xi. 55.—Report of trials of Colt's, and Deane, Adams, and Deane's, revolvers, by Board of Ordnance, 58.

RIDLEY, T. D. [Election, xv. 281.]

Rifled ordnance and projectiles. *Vide* **ARTILLERY.**

Rifles, breech-loading, McKenzie and Wentworth's, xix. 461.

—, Whitworth, strength of the material used for, their cost, the form of rifling, and results of competitive trials between the Enfield and Whitworth rifles, xix. 398.

RIGAUD, R. [Election, i. (1838) 21.]

RIGAUD, Rev. S. J. [Election, v. 338; resignation, xvi. 98.]

RIGBY, C. [Election, xvi. 371.]

RIGBY, J. D. [Election, x. 193.]

RIGBY, W. [Election, xix. 489.]

RILEY, E.

Iron and steel, Bessemer process for the production of malleable, xviii. 552.

RITCHEY, R. [Election, iv. 63.]

Drainage of towns. Sewerage of Edinburgh, xii. 65.

RITTERBANDT, Dr. L. A. [Telford medal, vi. 2.]

Boilers, substances composing the incrustation of, v. 198.—Difference between a mere deposit, or sediment, and an incrustation, 198.—Mode in which it is formed, 199.—Various attempts to prevent, 199.—Mode of action when muriate of ammonia is applied, 200.—Peculiar effects of the application of muriate of ammonia, 206, 210.—Inconveniences arising from incrustation in boilers, 211.

Patents. Great difference in patent laws and copyright acts, x. 217.—Appointment of a committee for examining applications for patents, 217.

Steam boilers. Necessity for an instrument to determine the saltiness of water, xii. 518.—Ditto for an indicator

RIVER CLEANSING MACHINE.

of brine saturation, out of reach of engineer, 519.—Application of muriate of ammonia to prevent incrustation in marine and other boilers, 519.—Experiments to test value of application, at Portsmouth, by order of the Admiralty, 519.

River cleansing machine (Hays, W. B.), i. (1837) 26.

RIVER LEE.

"Description of the navigation and drainage works, recently executed on the tidal portion of the river Lee." By N. Beardmore, xiii. 241.—Extent of the navigation, 241.—Acts of Parliament relating to, 241.—Limitation of size of barges, 241.—Navigation of three kinds, 241.—Four Mills Head part of navigation, 242.—Mr. Rendel's Report, of 1849, on the best means of improving the navigation, 243.—Tide-gates, near Old Ford lock, 244.—Lock at Marsh gate, on St. Thomas' creek, near Bow bridge, 244.—New cut and overfall of the Three Mills, 244.—Tidal and flood-gates near the Four Mills, 244.—Bromley entrance lock and bridge, 245, 247.—Junction cut near the Limehouse entrance, connecting this navigation with the collier dock belonging to the Regent's Canal Company, 249.—Armstrong's hydraulic machinery erected at the latter dock, 249.

Discussion.—Beardmore, N., 250.—Simpson, J., 251.

The river and its branches (Beardmore, N.), xiv. 70.—Rainfall in the district, 86.

"Description of the improvements on the second division of the river Lee navigation; with remarks on the position of canals generally, in reference to the development of their resources." By B. C. Despard, xvii. 386.—Enumeration of the works, 386.—The Old Ford locks, removal of the old lock, strata cut through in excavating for the foundations of the new lock, principal dimensions of the locks, and materials employed, 386.—Combined cast-iron pointing-rills and hollow quoins, 389.

RIVER NEWRY.

—Construction and dimensions of the lock-gates, 389.—The culverts and sluices, 390.—Wharf and towing-path walls between Old Ford and Homer-ton locks, 392.—New bank between Homer-ton lock and Wick-lane, 392.—Stop-gates at Pond-lane, 392.—Steam dredging between Lee bridge and Tot-tenham, 393.—Total cost of the works, 393.—Remarks on the position of canals, 393.—Traffic returns of the Grand Junction canal and of the river Lee navigation, as instances of canals work- ing under the disadvantage of competi- tion with railways, 393.—Ditto of the Trent and Mersey system, and of the Regent's canal, as illustrations of canals working in connection with rail- ways, 394.—Suggestions as to the sys- tem of management, 395.—Means for more efficiently working the traffic, 396.—Steam-tug on the Regent's ca- nal, constructed by Mr. Inshaw, 396.—Steam-towing barges on the Aire and Calder navigation, 397.—Mode of using tug-steamers, 397.—Construc- tion of new and improved works necessary, 398.

Discussion.—Beardmore, N., 399, 405.—Despard, R. C., 408.—Harrison, T. E., 409.—Hemans, G. W., 406.—Lawrence, F., 401.—Murray, J., 405.—Radman, J. B., 408.—Stephenson, R., 406.

RIVER NEWRY.

"On the improvement of the navigation of the river Newry." By Sir J. Rennie, x. 277.—Description of the course of the river, 277.—State of the navigation from the source to the town of Newry, 277.—Newry to Warren Point, 278.—Warren Point to the Irish Channel, 278.—Entrance of Lough Carlingford, 279.—Rise of the tide at the several places between Warren Point and Newry, previous to the improvement of the river, between Doyle's Hole and Warren Point, 279.—Difference of time of low water at the same places, 280.—Navigation previous to improvements difficult, uncertain, and dangerous, 280.—General appearance of the valley.

RIVER ORWELL.

280.—Geological features of the district, 280.—Canal from Newry to Fathom, recommended by the Board of Inland Navigation, in 1760, 281.—Floating dock at Newry, and canal to the river Bann, 281.—Irish Board of Inland Navigation abolished in 1829, 281.—Works transferred to a company in 1831, 282.—Determination to straighten, deepen, and improve river, to make a new entrance lock, to extend the canal (of increased dimensions), and to enlarge and deepen the old canal, 282.—First operation to increase the quantity of back water, 283.—Blasting rocks at Narrow Water Castle, upwards towards Squire's Point, and downwards towards Warren Point, 283.—Rubble guide-walls near Nun's Island and Narrow Water Castle, 283.—Dredging, blasting, and diving-bell operations, 284.—Increased flow of the tide, 284.—Mode of carrying out the extension of the canal, 285.—Construction and materials of entrance lock near Doyle's Hole, 286.—Ditto of the three pairs of gates, 287.—Population and trade of Newry, 289.—How far dredging and other artificial means may be carried, in the improvement of rivers, and where the canal becomes superior, both as to economy and certainty of result, 290.

Discussion.—Cubitt, Sir W., 293.—Rendel, J. M., 292, 293.—Bennie, Sir J., 290, 292.—Russell, J. S., 291, 293.—Ure, J. F., 293.

RIVER ORWELL.

"On the river Orwell and the port of Ipswich." By G. Hurwood, xx. 4.—State of the river and port about the beginning of the present century, 5.—Extracts from the Report of the Committee of 1803, 5; from Mr. Chapman's report of 1797, 6; of 1803, 9.—Works executed for improving the river since 1805, including the construction of a wet dock, and their effects, 10.—Tides in the Orwell, 12.

Discussion.—Bidder, G. P., 24.—Braithwaite, F., 18.—Brooks, W. A., 17, 24.—Bruff, P., 14, 23.—Cooper, J., 16.—

RIVER RHINE.

Curtis, J. G. C., 18, 24.—Hawksley, T., 17, 24.—Hurwood, G., 16, 18.—Murray, J., 16, 24.—Redman, J. B., 18.—Russell, J. S., 16.

RIVER RHINE.

"The engineering of the Rhine," including a translation of M. Van den Bergh's paper, "On the improvements of the Moselle." By G. B. W. Jackson, vii. 211.—Rise and course of the Rhine, and geological character of its bed, 211.—Table of the levels, widths, slopes, and depths of the Rhine, from its source to Holland, 214.—Table of the velocities and quantities of water in, 215.—Table of the levels, widths, slopes, and depths of the Rhine, through Holland to the sea, including the levels of the dykes, 216.—Table of the velocities and quantities of water in, 218.—Depths at high water, and at floods, in different years, 219.—Lowest waters in different years, 219.—Effects upon the level of the Rhine produced by the tributary streams, 219.—List of places where the principal breaches in the dykes have occurred since 1421, 220.—Result of floods and inundations along the Rhine, 221.—Construction of the present works on the Rhine, 221.—The French district, from Bâle to Lauterburg, 221.—Dams for closing up arms of the river, constructed with fascine bundles and solid basket-work, 222.—Dam at Raupkopf, 222.—Shore-preserving works, consisting of parallel walls and spurs, 224.—The Prussian district, from Lauterburg to Emmerich, 225.—Shore walls, 225.—On the improvements of the Moselle, 226.—Description of the river, 226.—Principal object aimed at in the proposed improvements of straightening the stream, and contracting it by a system of spurs, 227.—Weirs for damming up arms in the stream, 229.—Lighter works, constructed chiefly of fascine work, to further contract the stream, 229.—Stone walling for preserving the shores between Cologne and Düsseldorf, 231.—Mode of con-

RIVER SEVERN.

struction adopted by Wiebeking, for a system of down-stream spurs, 232.—Dam erected by Wiebeking, in 1790, at the Island of Honneff, close to Bonn, 232.—Outlet of the Sieg, 232.—Shore-covering, or arming, at Flehe, 233.—Shore-walling at Grimlingshausen, 233.—Improvements of the Ruhr, below this to Emmerich, beyond by the Byland cut, or canal, and new outlet at the Yssel, near Arnhem, 234.—Pannerden canal, at the first division of the Rhine below Lobeth, 234.—Drainage of lands throughout Holland, and method adopted for getting rid of the inland waters, 234.—Fascine spurs and arming on the Dutch Rhine, the Waal, the Leck, and the Meuse, above the reach of the tide, 235.—Action of the tides on the lower portion of the river, 236.—Table, experiments of Blanken on the tides, 1796-7-8, 238.—Table, by Bolstra, of distances and slopes up which the tide travels, 238.—Table, results of experiments by Bolstra, for ascertaining the average rise of tide and ebb in the Old and New Meuse, and in the Merwede, during 1739-40-41, 239.—Table showing duration of ebb and flood in the Meuse and Merwede, 240.—Table showing the heights of the crown of the dykes along the Rhine, the Waal, the Leck, the Yssel, and the Meuse, above the highest floods, 240.—Proposals to effect the letting off the surface-water of the Leck, 241.—Frequent ice-stoppages on the streams running through Holland, and system of improving the rivers in that country, 242.—Object to be aimed at for improving the Meuse at Rotterdam, 243.

Discussion.—Buckland, Dr., 243.—Crocker, B. W., 246.—Cubitt, Sir W., 245, 246.—Field, J., 244.—Russell, J. S., 244, 245.—Simpson, J., 246.

RIVER SEVERN.

Weirs and locks erected for its improvement, *iv*, 111, *et seq.*—Blasting marl rocks upon the, (Edwards, G.), 261; 370, *et seq.*

RIVER SEVERN.

"On the estuary of the river Severn." By W. Parke, v. 300.—Description of the course, 300.—Inclination of the surface of the water, 301.—Extent of country drained, 301.—Bristol Channel, 302.—Lift of the tide at different places, 302.—Description below its confluence with the Wye, 302.—Entrance to the Gloucester and Berkeley canal, 303.—Above Sharpness Point, 304.—At Hock Crib, 305.—Velocity of the tide-wave at Framilode, 306.—Relative levels of high-water in different parts, 306.—Neap tides, 307.—Capabilities for improvement as a navigation, 307.—Proposal for cutting a canal across the Horse-shoe, from Framilode to Hock Crib, 308.—One datum line for tidal reference, for whole coast of England, 309.

Discussion.—Atherton, C., 330.—Bald, W., 312, 314, 315, 317.—Bateman, J. F., 313.—Beamish, R., 314.—Brunel, I. K., 312.—Leslie, J., 313.—Redman, J. B., 333.—Rennie, Sir J., 310, 314, 331.—Russell, J. S., 313.—Taylor, J., 312.—Thomson, J., 314.—Thorold, W., 331.—Walker, J., 309, 311, 313, 316.

"Account of the works, lately constructed, for improving the navigation of the river Severn, with their effect in discharging the flood waters." By E. L. Williams, v. 340.—Lock and weir at Lincomb, 341.—Formation of an embankment across the old channel, 342.—Holt lock and weir, 343.—Bevere lock and weir, 344.—Locks and weir at Diglis, 344.—Stability of this series of locks and weirs, 345.—Effect of works, particularly the oblique weirs, 346.—Experiments on the flow of the under-current, 347.

Discussion.—Bateman, J. F., 350, 352, 358.—Bidder, G. P., 356, 357, 360.—Brunel, I. K., 351.—Cubitt, Sir W., 348, 351, 352, 355, 356, 357, 359.—Fairbairn, W., 352.—Farey, J., 358.—Graham, R. B., 360.—Gravatt, W., 359.—Russell, J. S., 359.—Stephenson, R., 351, 355.—Thomson, J., 356, 358, 360.—Williams, E. L., 357.

RIVER THAMES.

"Account of the works recently constructed upon the river Severn, at the Upper Lode, near Tewkesbury." By E. L. Williams, xix. 527.—Scheme of improvement laid down by Sir William Cubitt, in 1841, 527.—Parliamentary contest, and unsatisfactory result of experiment, forced upon the promoters, to dredge that portion of the river between Diglis and Ryall, instead of constructing a lock and weir at Ryall, as proposed, 528.—Determination to construct a lock and basin at the Upper Lode, 528.—Dimensions and details, 529.—Mode of carrying out the excavations for the lock pit, 529.—Concrete foundations for the walls and invert, 530.—Lock chamber, invert and wing walls, 531.—Weir, 531.—Process by which the base of the permanent dam was carried across the river, 532.—Cost of the works, 533.—Tugs used upon the river, 533.

Discussion. — Beardmore, N., 534. — Bidder, G. P., 544. — Brooks, W. A., 534. — Curtis, J. G. C., 535, 540. — Hawkaley, T., 539. — Hemans, G. W., 540. — Murray, J., 534. — Parkes, W., 538. — Scott, M., 539. — Williams, E. L., 540.

RIVER THAMES.

Strata at the site of the Thames tunnel (Walker, J.), ii. (1843) 29; (Brunel, Sir M. I.), 80; (Brunel, I. K.), ix. 18. — Waterway and rise of tides, &c., at London old bridge (Giles, F.), 87. — Sinuosity of the river advantageous to the navigation (Rowland, Capt.), xii. 19. — Experiments on the flux and reflux of the tide, xiii. 94, *et seq.* — Effect of the floods of the river Lee upon the lower reaches of the Thames (Beardmore, N.), 251; (Simpson, J.), 251.

"On the past and present condition of the river Thames." By H. Robinson, xv. 195.—Length and width of river, and height to which tide rises, 196.—Penning effect of the obstructions of Old London bridge, 197.—Successive Acts of Parliament for improvement of

RIVER WANDLE.

the navigation, 197.—Mr. Rennie's report of 1794, 199.—Plans for the improvement of the banks, 200.—Causes of the changes in the bed, 201.—Mr. Walker's evidence before the Committee on Metropolitan Improvements, in 1842, 201.—Provision of increased dock accommodation in the lower part of the river, 202.—The Thames considered as a drain for the district through which it passes, 202.—Scheme of Mr. Martin for large intercepting sewer, 203.—Intercepting sewers proposed in 1850 and in 1853 by engineers to Metropolitan Commissioners of Sewers, 203.—Proposed chain of locks to be constructed across the river, at London bridge, 206.

Discussion.—Bazalgette, J. W., 224.—Beardmore, N., 226, 231.—Bidder, G. P., 236.—Brunel, I. K., 229.—Clutterbuck, Rev. J. C., 227.—Daniell, Dr., 220.—Fowler, J., 233.—Gibbs, J., 224.—Hawkshaw, J., 230.—Haywood, W., 222.—Leach, S. W., 228.—Moorsom, Capt. W. S., 244.—Pearson, C., 216.—Redman, J. B., 210, 242.—Rendel, J. M., 240.—Rennie, Sir J., 221, 230.—Robinson, H., 207, 244.—Stephenson, R., 246.—Vignoles, C., 210, 230.

Improvements of the river during the last thirty years, xix. 111, *et seq.*—Relative effects of tidal scour and of upland waters upon the river, xix. 127, *et seq.*—Difference of level between the Nore and London (Bidder, G. P.), xx. 25.

River wall at New Houses of Parliament, i. (1840) 19.

RIVER WANDLE.

"On the rise and fall of the river Wandle; its springs, tributaries, and pollution." By F. Braithwaite, xx. 191.—The branch rising at Carshalton, 191.—Croydon branch, 193.—Table of gaugings south of Hack bridge, including both the foregoing branches, 196.—Table of the amount of sewage water which, if collected, would daily flow down a main pipe at Hack bridge, during heavy rains, 197.—The stream below Hack bridge, 198.—The Pickle,

RIVER WEAR.

201.—The river Graveney, 203.—Watershed of the river Wandle and of the Collier brook, 206.—Observations on the gaugings, 206.—Appendix—Summary of the gaugings of Collier brook, or river Graveney, 208.—Ditto, list of the mills on the Wandle, 208.

Discussion.—Bateman, J. F., 229.—Bidder, G. P., 209, 255.—Braithwaite, F., 210, 231.—Denton, J. B., 229, 240, 258.—Drummond, W., 238, 252.—Evans, J., 219, 237, 251.—Fenton, J., 217, 235.—Gibbs, J., 212, 233.—Grantham, R. B., 228.—Greaves, C., 247.—Haly, W. T., 240.—Hawshaw, J., 215, 251.—Hawksley, T., 213, 218, 230, 233, 249, 250, 253.—Homersham, S. C., 216, 235.—Lloyd, J. H., 251, 254.—Rawlinson, R., 218, 236, 246.—Rennie, Sir J., 212, 232.—Simpson, J., 211, 232.—Stephenson, G. R., 230.

RIVER WEAR.

"An account of the progressive improvement of Sunderland harbour and the river Wear." By J. Murray, vi. 256.—Position of Sunderland, 256.—Rise and progress of the coal trade in the county of Durham, 257.—Average burden and number of the vessels frequenting the harbour, from 1787 to present time, 257.—Population of Sunderland, 258.—Letters patent first granted by Charles II., in 1669, to Edward Andrew, Esq., to build a pier and lighthouses at, 258.—Extract from the preamble, 258.—Proposals submitted to Parliament, and dates of the several Acts obtained, for the improvement of the river, 258.—State of the river, and mouth of the harbour, between 1659 and 1719, 259.—Erection of the south pier, and its objects, 260.—Works of the Commissioners about the year 1726, 260.—State of the river from its mouth to New-bridge, in 1737, 260.—Report of Mr. C. Labelye on the injurious circumstances affecting the river and harbour, and proposed means of removing them, 260.—Opening out of the old Sledway, by Mr. Vincent, between the years

RIVERS AND ESTUARIES.

1752 and 1755, 263.—Effects of deepening the south channel, particularly injurious to pier-head, 263.—Survey of the river, and improvements proposed by Mr. Smith in November, 1758, 264.—Suggestions made by Mr. Robson, from 1758–67, and proposal for building a pier on the south rocks, 264.—Report of Mr. Wooler on the proposed pier, 265.—Extract from a paper containing a view of the state of the harbour from 1755–74, 266.—Mr. Shout's plan for rebuilding and extending the old south pier, with Mr. Smeaton's opinions thereon, 266.—Mr. Dodd's report on the river, harbour, and piers, 269.—Mr. Shout's alterations in the south pier, in the year 1804, 270.—Extracts from Mr. Jessop's report of December 19, 1807, 270.—Mr. Rennie's survey of the river, port, and haven, and rebuilding of the piers, 272.—Alterations in the north and south piers by Mr. Murray, 273.—Tides at Sunderland, and velocity of current, 275.—Dredging in the harbour, 275.—Position of the present harbour, 276.—Formation of the wet docks, 276.

Discussion.—Bidder, G. P., 282.—Edwards, G., 283.—Murray, J., 277, 278, 281.—Rennie, Sir J., 280, 283.—Simpson, J., 278.—Walker, J., 281, 282.

Construction of the wooden piers at the mouth of the river Wear (Murray, J.), xviii. 98.

Vide also DOCKS, Sunderland.

RIVERS AND ESTUARIES.

Ancient method of navigating rivers (Rennie, Sir J.), iv. 111.

Avon (Glamorganshire), diverted from its course in forming the harbour of Port Talbot (Palmer, H. R.), ii. (1842) 188.—Caused to excavate its own new channel, 188.

Axe, changes in the estuary of, from the action and movement of shingle and of the material forming the coast (Green, J.), vii. 360.

Bann, County Down, Ireland, vii. 253, *et seq.*

RIVERS AND ESTUARIES.

Bourne, at Croydon (Braithwaite, F.), xx. 193, *et seq.*
 —, in Hertfordshire, xx. 227.
 Bulbourne, a tributary of the Colne (Clutterbuck, Rev. J. C.), ii. (1842) 156.
 Calder, mode of protecting the banks of the, (Bull, W.), ii. (1842) 130.—Height of floods in, 130.
 Changes in, causes in constant operation tending to alter the outline of the English coast, to affect the entrances of, and to form shoals and deeps in the bed of the sea (Harrison, J. T.), vii. 327.
 Chess, a tributary of the Colne (Clutterbuck, Rev. J. C.), ii. (1842) 156.
 Clyde, mean-tide level of, (Bald, W.), v. 314.—Improvements in, and the effects produced (Walker, J.), 316.—Further observations on, (Bald, W.), 317.—Extracts from various reports relative, to the importance of the ebbing tidal power, 318.—Mr. Rennie, 318.—Mr. Telford, 318.—Mr. Whidby, 318.—Mr. Logan, 319.—Mr. Walker, 319.—Importance of the river to Glasgow, 319.—Channel through Port Glasgow bank, for improving the navigation of the lower Clyde, 319.—Channels through the Puddle Deep bank at Garmoyle, the Dumbarton bank, and the Long Dyke bank, 320.—Mode adopted for deepening and clearing the bed of the river between Erakine ferry and the Newshot Isle, by means of diving-bells and steam-dredgers, 320.—Tidal wave of, and Mr. Scott Russell's report thereon, 322.—Expediency of opening the south channel of the river, and its advantages to the navigation, 322.—Table of the velocity of the tidal waters, with remarks, 324.—Expense of opening the south channel, and its effects, 325.—Mr. Logan's proposal for making a dock, or ship-basin, within the south channel of the Newshot Isle, 327.—Removal of the shoal at Spiers' Hedge, and of a point of land at White Inch, and also at Govan, 328.—Statement of the works executed on the river since 1839, 329.—Quantity

RIVERS AND ESTUARIES.

of materials dredged from the bottom of the river, the number of dredgers employed, and the cost, 330.—Weight of the above materials, 331.—Works executed for the improvement of the river (Atherton, C.), 330; (Thorold, W.), 331; (Redman, J. B.), 333; (Russell, J. S.), vii. 245; (Cubitt, Sir W.), 246; (Rennie, Sir J.), 290, 292; (Russell, J. S.), x. 291; (Rendel, J. M.), 292.—Their effects on the land floods (Ormiston, T.), xix. 110; (Locke, J.), 111, 112.
 Colne (Clutterbuck, Rev. J. C.), ii. (1842) 155, 156.
 Conan (Murray, J.), xx. 329.
 Cromarty, frith of, (Murray, J.), xx. 329.
 Damocda, embankments of the, and its liability to violent floods (Greaves, C.), xvii. 523; (Sibley, G.), 524.
 Danube and other rivers in Hungary. Improvements formerly effected by spurs for deepening the channel, but now effected by reclaiming the side arms (Croker, B. W.), vii. 247.
 Dee, in Cheshire, system of spurs in, (Russell, J. S.), vii. 244.
 Dornoch, frith of, (Murray, J.), xx. 323.
 Douro, bar off Oporto (Gibbs, J.), xv. 453.
 Exe, change of entrance from the movement of the shingle (Green, J.), vii. 360.
 Forth, frith of, tidal phenomena of, (Russell, J. S.), xx. 341; (Giles, A.), 345.
 Gade, a tributary of the Colne (Clutterbuck, Rev. J. C.), ii. (1842) 156.
 Humber, coffer dam at Great Grimsby (Neate, C.), ix. 1.—Estuary, 2.—Silt of the, (Rendel, J. M.), 10; (Buckland, Dr.), 14, 20.
 Hydrology of, on testing the quantity of drainage water carried off by, (Bald, W.), v. 312.—Theory of tidal rivers and running streams (Russell, J. S.), viii. 329.—Estuary maintained by the flux and reflux of the tide almost without the aid of upland water (Hawkaley, T.), xii. 16.—Effect produced by the 'pouch' in a tidal river (Hawkaley,

RIVERS AND ESTUARIES.

- J.), 18.—Longitudinal section of the tidal flow in a river (Radford, W.), 21.—Treatment of rivers (Rendel, J. M.), 22.—Effect of under-drainage on the supply of water to rivers and streams (Bidder, G. P.), xix. 105.—Relative value of upland and tidal waters in estuaries and in rivers discharging into tidal estuaries and within tidal action (Hawksley, T.), 118.—Formation of bars, and asserted advantage of curved channels, 119.—Source of rivers (Braithwaite, F.), xx. 18.—Laws of absorption and of evaporation (Braithwaite, F.), 281.—Proportion of the rainfall flowing off by means of rivers (Bidder, G. P.), 256.
- Improvement of, (Sibley, R.), i. (1841) 100.—Desirability of having communications relative to the present state of important rivers, and their capability of improvement, v. 314.—Necessity for their gradual improvement, 331.—Works for narrowing the outlet of rivers (Jackson, G. B. W.), vi. 100.—Relative advantages of rendering rivers navigable, by means of long diagonal weirs, with side locks and gates, or by means of aide embankments and facing to the original shores (Oroker, B. W.), vii. 246. *vide* also RIVER SEVERN.—Principle to be kept in view in the improvement of channels and estuaries (Russell, J. S.), 365.—Relative expediency of improving a tidal river, of making a canal, or of damming up a river and introducing locks, x. 291.—Where should artificial navigation begin and natural navigation end (Rendel, J. M.), 292.—Effects of improvements in navigation and drainage, xi. 159.
- “On the improvement of tidal navigations and drainages.” By W. A. Brooks, xii. 1.—Difference in the physical conditions of tidal rivers, 2.—Progress of the tidal wave, throughout the entire period of the flow, the true test of the condition of a river, 7.—Fallacy as to the greater utility of the flood current, over that of the ebb, in deepening the

RIVERS AND ESTUARIES.

- beds of rivers, 8.—Tidal energy, or power, of a deep-water navigation, as compared with a shallow one, 9.—Works for training the current of a river, 10.—Influence upon the drainage of a country, of works constructed for the improvement of navigations, 11.
- Discussion.—Blackwell, T. E., 14.—Brooks, W. A., 21.—Coddington, Capt., 13.—Hawksley, J., 18.—Hawksley, T., 16.—Hood, Capt., 15.—Locke, J., 20.—Moorson, Capt. W. S., 20.—Murray, J., 13.—Radford, W., 21.—Rendel, J. M., 22.—Rowland, Capt., 19.—Russel, J. S., 17.—Stephenson, R., 12.
- Improvement of. Embanking rivers with the view of preventing inundation (Sibley, G.), xvii. 525.—Principles of improving rivers in flat countries (Grantham, R. B.), xix. 76.—Necessity for a complete record of the phenomena attending works for the improvement of rivers (Bidder, G. P.), 105.—Method which should be pursued in canalising a river (Beardmore, N.), 535.—Method of increasing the hydraulic mean depth dependent upon the supply of water from the catchwater basin and the conformation of the channel of the river (Curtis, J. G. C.), 535.—Construction of weirs in a tidal river, and the position of the lowest weir, so as not to obstruct the tidal flow, and to facilitate the passage of the flood water (Hawksley, T.), 540; (Hemans, G. W.), 540; (Curtis, J. G. C.), 540; (Williams, E. L.), 540.
- India, embankments or bunds for confining the waters of the Ganges (Tremmenheere, Maj.-Gen.), xvii. 488.—Facilities for inland river navigation in the northern portion of Hindostan, 498.—System of dealing with, particularly in the Madras Presidency, and the irrigation works in connection with them (Grantham, R. B.), xix. 80; (Rennie, Sir J.), 98.
- Italy, especially those discharging into the plains of Lombardy, and the irrigation works in Northern Italy (Grantham, R. B.), xix. 82.

RIVERS AND ESTUARIES.

- Mersey, peculiarities of, (Hawksley, T.), xii. 17; (Hawkshaw, J.), 18.—Possible effect of contracting the channel of the river through the 'pouch' or bay of the Sloyne (Rowland, Capt.), 19; (Locke, J.), 20; (Brooks, W. A.), 22.
- Moselle, translation of M. Van den Bergh's paper "On the improvements of the Moselle." By G. B. W. Jackson, vii. 211. *Vide also RIVER RHINE.*
- Mutla, capabilities of, for the formation of a subsidiary port (Longridge, J. A.), xix. 620; (Bidder, G. P.), 624.
- Neva, difference between that river and the Thames (Haywood, W.), xv. 223.
- Nile, rise of the, at Cairo (Stephenson, R.), x. 377.—Barrage of the, 379.—Steam ferry at Kaffre Azzay at (Sopwith, T.), xvii. 53.—Depth of deposit and rate of current (Stephenson, R.), 65.
- Norfolk estuary (Stephenson, R.), xii. 13.
- Obstructions in. "On the obstructions to navigation in tidal rivers." By J. T. Harrison, viii. 310.—Circumstances which affect the deposition of the solid material, 310.—Action of water, the chief agent in giving motion to the materials which cause the obstructions, 311.—Varieties in the motion of the water, due 1st, to a curve in the channel, 312.—Ditto 2nd, to the wave motion of the surface, 312.—Ditto 3rd, in a stream of unequal depth but of uniform width, 314.—Effects of the motion of water on the materials subjected to its action, 314.—Ditto in a tortuous channel varying in depth, 314.—Ditto when the longitudinal section presents a succession of deeps and shallows, 315.—Ditto when standing waves are found, 315.—Application of these circumstances in explanation of the obstructions existing in the bed and at the entrance of tidal rivers, first, as to the effects produced by river water in its own channel, 315.—Ditto when it discharges itself into a large body of water, such as a lake, where

RIVERS AND ESTUARIES.

- there is no rise and fall of tide, 317.—Ditto into an arm of the sea, 317.—Ditto, in which the water rises and falls without much perceptible current, 319.—Action of the sea without the bar, or entrance to the river, and the circumstances which affect it, 319.—Observations on the motion of water in rivers and estuaries, when the tidal wave sets directly up them, 319.—Ditto when the river is at right angles to the coast, along which the great tidal wave sweeps, 320.—Circumstances which lessen the quantity of water flowing into an entrance, 322.—Want of experiments to ascertain whether the velocity of a wave is diminished by the motion of the water in which it is propagated being opposed to it, 323.—Circumstances which conduce to the removal of bars, 323.—Advantage from the presence of bars, 325.—Action of the water upon the materials forming the bed of the channel, 325.—Measures necessary to remedy the injurious deposition of materials in rivers, 327.—Mode of carrying out improvements in tidal rivers, 329.
- Discussion.—Russell, J. S., 329.
- Obstructions in. Formation of shoals in rivers (Rowland, Capt.) xii. 19.
- Ouse, Norfolk. *Vide DRAINAGE, Arterial.*
- Ouse, Sussex, works for improving the harbour of Newhaven, formed by the outfall of the, (Hood, Capt.), xii. 15; (Russell, J. S.), 17; (Brooks, W. A.), 22.
- Ouse, Yorkshire. "On the improvement of navigable rivers, with a description of a self-acting waste board at Naburn lock, on the river Ouse." By H. Renton, i. (1840) 26.
- Crossing of the Hull and Selby railway (Bray, W. B.), iv. 86.
- Pollution of, by town drainage and sewage, remarks in course of discussion on river Wandle, xx. 232.
- Régime of, premium for a Paper on, offered by Mr. G. P. Bidder, in his address, on taking the chair for the

RIVETING.

- first time after his election as President, xix. 221.
- Ribble, improvements in the navigation of the, (Stevenson, D.), i. (1848) 81.
- Sid, changes in, from the action of the materials forming the coast (Green J.), vii. 360.
- Stour, in Essex, account of its condition, previous to being improved (Cubitt, Sir W.), iv. 111.—Tidal phenomena of the rivers Orwell and Stour (Curtis, J. G. C.), xx. 18.—Comparative configuration of the high and low water channels of the two estuaries, 20.
- Tees, system adopted by Mr. Brooks for the improvement of the, (Simpson, J.), vii. 246; (Cubitt, Sir W.), 246.
- Theiss, Hungary, works for controlling its waters (Crocker, B. W.), vii. 249.
- Tweed, experiments and observations on the velocity and regimen of the, (Bruce, G. B.), x. 231.
- Tyne, régime of the, effect of the existence of Jarrow Slake upon the tidal flow, influence of the Tyne docks on Jarrow Slake, of the works at the mouth of the river, &c., xviii. 513, *et seq.*
- Ver, a tributary of the Colne (Clutterbuck, Rev. J. C.), ii. (1842) 156.
- White Körös, works executed on the, (Crocker, B. W.), vii. 249
- Y (Holland), (Conrad, Chev.), ii. (1842) 172.
- Yare, crossing of Breydon Water, by the railway from Yarmouth to Norwich, and works imposed upon the company by the Admiralty (Bidder, G. P.), xviii. 521.
- Vide also Coasts.*
- Riveting, forging, shearing, and punching machinery (Sawyer, T. S.), xvii. 178.
- ROADS.
- Construction of. "On the construction of roads on deep bogs and moss." By W. Bald, i. (1838) 50.
- Dynamometer for measuring the friction on, (Carr, H.), i. (1840) 52.
- General review of road-making (Bennie, Sir J.), v. 68.
- Grand Trunk, of India, its dimensions,

ROADS.

- the materials employed, details of the service for the construction and repair of, cost, causes of the delay in completing the bridges over the rivers on the line of the, and recent extensions (Tre-menheere, Maj.-Gen.), xvii. 501.
- Improvement of. "On the improvement of the roads, rivers, and drainage, of the counties of Great Britain." By R. Sibley, i. (1841) 100.
- Instrument for describing the profile of, (Carr, H.) i. (1840) 56; (Chapman, H.), 86.
- Macadamized, for streets. "On macadamized roads, for the streets of towns." By J. P. Smith, xiii. 221.—That road not the cheapest which costs the least in direct expenditure merely, 222.—Roads should never be allowed to become degraded, for want of timely repairs, 222.—Mode of making a good macadamized road, 223.—Ditto, illustrated in the case of a leading thoroughfare in Birmingham, 224.—Roads should not be allowed to become dirty, 225.—Mechanical cleansing, by Whitworth's machine, preferable to all other systems, 225.—Result of an experiment, in the Quadrant, London, to ascertain whether useful grit was removed by water and machine-sweeping, 226.—Draught upon macadamized roads, 227.—Comparative wear and tear of horses and vehicles upon macadamized roads and upon pavements, 227.—Cost of two systems, 227.—Conclusions deduced from inquiry, 228.—Appendix—Statement of the cost of maintaining the streets and roads in the borough of Birmingham, for the year 1853, 229.—Ditto, detail of the cost of maintaining, cleansing, and watering, 229.
- Discussion.—Appold, J. G., 235.—Baylis, J., 236.—Beardmore, N., 236.—Browse, H., 234.—Burt, G., 237.—Cawley, C. E., 230, 231.—Hawshaw, J., 237.—Haywood, W., 231, 234, 236.—Legg, G., 236.—Newlands, J., 238, 240.—Redman, J. B., 240.—Simpson, J., 234.—Smith, J. F., 229, 231, 233, 237.—Taylor, W., 239.—Vignoles, C., 237.

ROBE

- Whitworth, J., 231. — Wood, H., 236.
- Mangaratiba Serra, means of communication in empire of Brazil, works of the, and of the Mauá, the first Brazilian railway (Webb, E. B.), xix. 240.
- New South Wales, Victoria, and South Australia, (Annual Report,) xx. 110.
- Vide also PAVEMENTS.*
- ROBE, Lieutenant-Colonel A.W., R.E. [Election, i. (1838) 47; Member of Council (1839), 27; memoir, ix. 105.]
- ROBERTS, E. [Election, xix. 461.]
- ROBERTS, Lieutenant J., R.M.A. [Election, vi. 134.]
- Electric telegraph, objections to underground system of wires for, xi. 372.
- ROBERTS, R. [Election, i. (1838) 24.]
- Iron and steel. Case-hardening, i. (1839) 30.
- Machine, Jacquard, or multifarious perforating, for punching boiler-plates, and amount of work performed by it, in preparing the plates for the tubular bridges at the Conway, and over the river St. Lawrence, Canada, xvii. 191.
- Patents. Many useful inventions never patented for want of funds, x. 214.
- Ships and steam vessels. Details of a proposed steam-packet ship, xiii. 39.—Reasons of the unsatisfactory performance of many steam vessels, 40.
- ROBERTS, S. U. [Election, xiii. 364.]
- ROBERTS, S. W.
- Railways. "On railways in America," (Walker, J.), i. (1839) 43.
- ROBERTSON, A. J. [Election, iii. 66; Telford premium, vi. 2.]
- Breakwaters and piers. Estimated cost of Portland, xviii. 109.—Alderney, 145.—Proposed cast and wrought iron, xix. 665.—Form and materials for, 665.
- Exhibition in 1851, construction of the building for the, x. 180.
- Machinery. "Description of the machinery erected by Messrs. Maudslay, Sons, and Field, at the Minorics station, for working the London and Blackwall railway," v. 143.
- Piles, driving, xviii. 513.

ROBINSON.

- Viaduct over the valley of the Dee, and its cost, ix. 293.
- Waves, mechanism of, xviii. 145.
- ROBERTSON, G. [Election, xvi. 226; Telford medal, xviii. 174.]
- Concrete, tendency of, to swell, when made of quick-lime, xvii. 440.—Experiments on the crushing of cement stones and mortars, 441.
- Mortar. "An investigation into the theory and practice of hydraulic mortar, as made on the new works of the London Dock Company, 1856-57," xvii. 410.—Remarks, 435.—Methods of preparing mortar on works in this country, and specimens of different kinds, 435.
- ROBERTSON, H. [Election, viii. 273.]
- Fuel. Use of coal, in place of coke, on railways, xvi. 31.—Form of grate adopted for this purpose by Mr. Jeffreys, in the locomotives on the Shrewsbury and Hereford railway, 32.—Results of burning coal in ditto, 32.
- ROBERTSON, H. (Glasgow.)
- Lewis. "A drawing and description of a new Lewis," i. (1837) 26.
- ROBERTSON, J. [Election, xiv. 42.]
- Robertson's method of trussing, or bending, and putting the staves together, in the manufacture of caaks by machinery, xvii. 38.
- ROBINSON, A. [Election, xiii. 364.]
- ROBINSON, C. [Election, i. (1839) 42.]
- ROBINSON, Dr. [Election, ii. (1842) 184.]
- ROBINSON, H. [Election, viii. 164; Telford medal, xvi. 92.]
- River Thames. "On the past and present condition of the river Thames," xv. 195.—Remarks, 207.—Improvement of the sanitary condition of the river, 207.—Construction of proposed chain of locks across the river, just above London bridge, 207.—Objections to ditto, 207.—How to get rid of flood water, 208.—Proposed intercepting sewers, 209.—Probable effect of the works proposed by him for the improvement of the, 244.
- ROBINSON, H. G. [Election, viii. 164.]
- ROBINSON, H. O. [Election, i. (1841) 83.]
- ROBINSON, J. [Election, xviii. 490.]

ROBINSON.

- ROBINSON, J. S. [Election, i. (1841) 129; resignation, xii. 121.]
- ROBINSON, Lieutenant F., R.N.
Lighthouses. Screw-pile lighthouse at Fleetwood-on-Wyre, vii. 140.
- ROBINSON, M. R. [Election, xx. 586.]
- ROBINSON, R. A. [Election, xi. 477; Telford medal, xv. 81, 104.]
Steam navigation, &c. "On the application of the screw-propeller to the larger class of sailing vessels," xiv. 375.—Remarks, 414.—'Royal Charter' belonging to Liverpool and Australian Navigation Company, 397.
- ROBINSON, S. [Election, iii. 66.]
- ROBINSON, Dr.
Water-wheels, his theory of, (Mallet, R.), ii. (1843) 60.
- ROBINSON, Sir J.
Screws, Shanks and Co.'s lathe for cutting, ii. (1843) 144.
Waves, depth and force of, at Madras, ii. (1842) 128.
Wells. Artesian well at the Abattoir de Grenelle, Paris, ii. (1843) 140.
- Robinson's method of backing and hollowing, in the manufacture of casks by machinery, xvii. 38.
- ROBSON, N. [Election, iv. 291.]
- ROCKS, primary, on the vertical structure of the, and the general character of their gold-bearing varieties (Hopkins, E.), xx. 48.
- Rodman's, (Lieutenant, U.S.) system of casting heavy guns hollow on a chilled core, xviii. 341; xix. 363, *et seq.*; xx. 414, *et seq.*—His perforated cake powder, xx. 414.
- ROE, G.
Drainage of towns. Letter from him, as to substitution of brick sewer for pipe drain at Holloway (Smith, T.), xii. 72.
- ROE, J. [Election, ii. (1842) 122.]
Drainage of towns. "On the causes of accumulation of deposit in sewers, and on the hitherto generally prevalent mode of removing the same, with a description of a new flushing apparatus used for cleansing the sewers in the Holborn and Finsbury divisions," ii. (1842) 132.

ROOFS.

- Drainage, extract from a letter from him, dated December 3, 1852, as to size of sewers and amounts of rainfall, xii. 96.
—Ditto from his annual report, of January 29, 1847, as to ditto, 97.
- ROE, J. P. [Election, ii. (1842) 56.]
- Röebling's suspension railway bridge over the Niagara, xvi. 459; xiv. 459.
- ROENTGEN, G. M. [Resignation, x. 72.]
- ROGERS, —.
Sea-light tower, proposed circular wrought-iron, and manner of mooring, xv. 16.
- ROGERS and CLEWSON.
Gold. Extract from their remarks, as to gold districts of Virginia, U.S. (Hopkins, E.), xv. 69.
- ROGET, Dr. [Election, i. (1838) 26.]
- ROMAINS, W. [Election, i. (1838) 17.]
- Roman cement, v. 35.
- RONAYNE, J. P. [Election, xv. 281.]
- RONEY, Sir C. P. [Election, viii. 164.]
Dublin Exhibition, xii. 243.
Railways in Ireland, effect of guarantees in encouraging the formation of, xviii. 41.—Effect of the introduction of, on the habits of the people, 41.
- Roofing, Paxton, used in the building for Exhibition of all Nations in 1857, x. 151.
- ROOFS.
Brick arches for, as cheap as wood and slates (Smith, J. of Deanston), ii. (1842) 145.
- Buckingham Palace. "Description of the roofs over Buckingham Palace, covered with Lord Stanhope's composition." By P. Hogg, ii. (1843) 94.—Proportion of materials, mode of preparation, and of application of the composition, 94, 96.—Advantages of the composition, 95.—Causes of the reported failure at Mr. Naah's house, 95.—Durability of various roofs covered with the composition, 95, 96.
- Discussion.—Davison, R., 97.—Hogg, P., 96.—Moreland, R., 97.—Nixon, C., 96.—Poynter, A., 96.—Sibley, R., 96.
- Clay pots and hollow bricks used for (Vabre, M.), xiv. 523.
- Collar. "On the construction of a collar roof, with arched trusses of bent timber,

ROOFS.

- at East Horsley Park." By the Right Hon. the Earl of Lovelace, viii. 282.—Dimensions and details of the different members, 282.—Ribs bent to the requisite curve by steam, 282.—Col. Emy's roofs for large spans, 283.—Mode of setting out the arches, 283.—Ancient roofs erected in the 15th and 16th centuries, 284.
- Discussion.—Brunel, I. K., 285.—Buckland, Dr., 286.—Lovelace, Earl of, 284.—Vignoles, C., 286.—Walker, J., 286.
- Corrugated iron, at the terminus of the Eastern Counties railway (Evill, W.), iii. 288.
- Covering. "On a new mode of covering roofs with planking." By W. Cubitt, i. (1840) 68.
- Cubitt's works, Thames-bank. "Description of two wrought-iron roofs over the building at Mr. Thomas Cubitt's works, Thames-bank." By E. Adams, i. (1841) 96.
- Exhibition of all Nations in 1851, experiments as to strength of roof-trusses and girders (Wyatt, M. D.), x. 144.
- Flat. "On the construction of flat roofs with earthenware pots." By F. W. Simms, i. (1838) 5.
- Discussion.—Simms, F. W., 6.
- Iron, constructed so as to resist heat and cold (Fairbairn, W.), ii. (1843) 126.—Ditto over the reservoir at the Glasgow water-works (Mackinn, D.), 140.
- Laminated timber, erected at the new church at Cambo (Green, B.), v. 231.—Ditto, proposed for a house in Newcastle, 231.
- Lime-street station, Liverpool. "Description of the iron roof over the railway station, Lime-street, Liverpool." By R. Turner, ix. 204.—Objections to ordinary railway roofs, 204.—Construction of this roof, 205.—Details of wrought-iron box beam for supporting a portion of one side of the roof, 207.—Cost of structure, 208.—Appendix I., containing details of experiments for ascertaining the strength of the construction, 209.—Ditto II., testimonials in favour of it, 210.

ROOSMALECOQC.

- Discussion.—Dockray, R. B., 213.—Errington, J. E., 213.—Locke, J., 212, 214.—Pim, J., 213.—Turner, R., 211.
- Lime-street station, Liverpool, experiments upon the ribs (Locke, J.), xviii. 361.
- Marshall's flax-mill, Leeds (Combe, J.), ii. (1842) 142.
- New-street station, Birmingham. "Description of the iron roof, in one span, over the joint railway station, New-street, Birmingham." By J. Phillips, xiv. 251.—Principal dimensions, 253.—Details of different parts, 253.—Test of one of roof-trusses, 259.—Construction of scaffolding for erecting roof, 259.—Total weight of iron-work and cost, 261.—Observations upon the contraction and expansion of the roof, 261.—Appendix, showing the scantlings and weights of the principal parts of the roof, 263.
- Discussion.—Beardmore, N., 270.—Bidder, G. P., 270.—Cowper, E. A., 264, 270.—Fowler, J., 264, 268, 271.—Fox, Sir C., 265, 266.—Gregory, C. H., 266.—Hawkshaw, J., 271.—Hemans, G. W., 265.—Henderson, John, 268, 271.—Maudslay, H., 267.—May, C., 266, 271.—Moorsom, Capt., 272.—Simpson, J., 265, 272.—Stephenson, R., 270.—Strapp, J., 267.—Turner, R., 268.—Woods, E., 267.
- St. George's Church, Dublin. "Description of the methods adopted for raising and sustaining the sunken roof of St. George's church, Dublin." By R. Mallet, i. (1841) 92.—State of the roof, and causes of failure, 92.—Remedies proposed, 93.—Weight, and disposition of, 93.—Mode of sustaining the roof, 94.—Cost, 95.—Weight of iron-work used, 96.
- Simpson and Co's factory. "Description of the roof of Messrs. Simpson and Co's factory." By J. Boustead, ii. (1842) 91.
- Smith's weaving-shed (Smith, J., of Deanston), ii. (1842) 148.
- ROOSMALECOQC, A. H. [Election, ii. (1843) 183; resignation, xiii. 194.]

ROPES.

Ropes.

Blackwall railway, failure of hemp and substitution of wire (Robertson, A. J.), v. 153.

Flat. "Description of a machine for sewing flat ropes." By E. Birch, i. (1841) 171.—Strength of, 171.

Manufacture of. "On Huddart's rope manufacture." By G. D. Dempsey, i. (1838) 38.—Relative strength of the cables of Huddart's, and the ordinary manufacture, 39.

— "On Huddart's rope machinery." By E. Birch, i. (1838) 89; ii. (1842) 57, *et seq.*; (Rennie, Sir J.), v. 54.

Wire, used on the Blackwall railway, peculiarities of construction of, v. 155, *et seq.*—Opportunity of testing Newall's, on Oldham incline (Laws, Capt. J. M.), x. 248.

Rosenberg's method of trussing, or bending, and putting the staves together, in the manufacture of casks by machinery, xvii. 38.

Rotating - chambered - breech fire-arms (Colt, Col. S.), xi. 30.

ROSS, O. C. D. [Election, vi. 431.]

ROSSE, Earl of. [Election, viii. 273.]

ROSSER, S. E. [Election, xiii. 475.]
Furnaces, admission of air to, xiv. 31.

ROSSER, W. [Election, xv. 348.]

ROTATION OF THE EARTH.

"On the demonstration, by means of two pendulums, of the rotation of the earth." By H. Cox, x. 320.—Evidence of, from mechanical experiments performed at, or near, the earth's surface, 320.—Mathematical theory of the question by Huygens, 320.—Mechanical test by Newton, 321.—Investigation of the same subject by Poleni, 321.—Experiment of M. Foucault, 321.—Experiment to show the effect which would be observed in the oscillation of a pendulum, suspended from a point fixed vertically above either pole of the earth, 322.—Diurnal motion of the earth about its poles, may be produced by two uniform rotations, one of which is about an axis passing through any other place and

RUSSELL.

its antipos, 323.—Difficulties of pendulum experiment, 324.—Method of exhibiting the rotation of the earth by means of two pendulums, 324.

ROTOR, B.

Patent laws, application of the, to the colonies, x. 211.

ROTH, Dr.

Calculating machines. Automaton calculator invented by him (Wertheimer, —), iii. 68.

ROTHWELL, P. [Election, i. (1838) 38; memoir, ix. 100.]

ROUSE, H. J. [Election, xix. 489.]

ROUTH, J. [Election, i. (1838) 46; resignation, xi. 93.]

ROUTLEDGE, T. [Election, i. (1841) 87.]

ROWE, R. R. [Election, xv. 47.]

ROWLAND, Captain.

Rivers and estuaries. Possible effect of contracting the channel of the Mersey, through the 'pouch' or bay of the Sloyne, xii. 19.—Formation of shoals, 19.—Sinuosity of the Thames is advantageous to the navigation, 19.

ROWLES, H. [Election, i. (1838) 12; memoir, i. (1841) 15.]

'Royal George,' gun raised from the wreck of, used to cast the frame of the lantern of the Point of Ayr lighthouse, ii. (1842) 154.

Rubble, difficulty of defining what is, x. 238.

Rubble béton and concrete, employment of, in works of engineering and architecture (Rennie, G.), xvi. 423.

Rubble walls, weight they can bear, ii. (1842) 177.—Should never exceed 3 feet in thickness, 178.

'Ruby' steam-vessel, comparison of power of engines, with tonnage, i. (1841) 65.

RUMBALL, T. [Election, xiii. 421.]

RUMBLE, F. [Election, i. (1840) 18; resignation, xiii. 134.]

RUSSEL, R.

Foundations of iron viaduct at Manchester, xi. 234.—Mode of testing the beams, 234.—Table of results, 235.

RUSSELL, C. S. [Election, i. (1839) 63.]

RUSSELL, J. Scott. [Election, vi. 431; Member of Council, xi. 84; xii. 112; xiii.

RUSSELL.

- 123; xiv. 97; xv. 76; xvi. 88; xvii. 70; xviii. 164; xix. 132; xx. 108.]
- Archea. Application to practice, of Professor Moseley's theory of the condition of stability of arches, v. 466.
- Axles. India-rubber tube for conveying oil to a revolving crank journal, xii. 457.
- Boilers, priming in, viii. 185.
- Breakwaters, &c. "On the practical forms of breakwaters, sea-walls, and other engineering works exposed to the action of waves," vi. 135.—Remarks, 143.—Peculiar form of sea-wall and parapet, to reflect the waves without breaking them, and of the action of the waves upon this wall, 143.—Form of walls governed by local circumstances, 148.
- Two classes of waves to which sea-works are exposed, proposals for substituting a system of gridirons, or wave screens, of open timber and iron piling, for the usual perpendicular, or sloping pier of masonry, and practical forms of breakwaters, sea-walls, and other engineering works exposed to the action of waves, xix. 651.
- Bridges. Establishment of Government Boards and Commissions, ix. 242.—Refusal of an Inspecting Officer of railways to pass a tubular-girder bridge, 243.—As to submitting this case to the Council for their support and aid, 243, 245.—Additional strength gained by the continuity of the girders in the Torksey tubular bridge, 271.—Mode of building piers of bridges and viaducts, x. 301.
- Charts. Contour maps of the bottom of the sea, xx. 341.
- Coasts, &c. Movement of shingle, and formation of Dungeness Point, xi. 212.—Configuration of the beaches at Selsey Bill and Oseil Bank, and at Dungeness, 221.
- Coffer-dam and other works at Great Grimsby, ix. 11.
- Colliers, screw and sailing, xiv. 360.—Ballasting ditto, 362.—Application of auxiliary power for long voyages, 410.
- Dock entrances, vii. 181.

RUSSELL.

- Drainage of towns. Non-publication of results of experiments by Trial Works Committee of Metropolitan Sewers Commission, xiv. 314.
- Dredging, cost of, x. 293.
- Dynamometer used in his experiments on traction on railways and on board vessels, v. 281.—Means employed to give motion to the registering apparatus, 283.—Diagrams produced, 285.—Sir John Macneill's dynamometer, 285.—M. Morin's use of his ditto, 285.
- Engine, Du Trembley's combined-vapour, xviii. 279.
- Exhibition in 1851, construction of the building for the, x. 170.
- Fluids, elastic, discharge of, under pressure, vi. 386, 387.
- Fluids, resistance to bodies moving in, Mr. Heppel's mode of determining the relation between the velocity and, v. 271.—His mode of ditto, by means of Pitot's tube, and a dynamometer, 272.—Cause of the incongruities in the results of experiments for determining ditto, 279.—Use of Pitot's tube, 280.
- Fuel, consumption of, in steam vessels, xiii. 53.
- Girders. Whether 'box' form commercially the best for wrought-iron girders, xi. 233.—Mode of testing the girders for iron viaduct at Manchester, 236.—Form of wrought-iron girder of ditto, 236, 238.
- India rubber, proposal that a series of experiments should be tried on the elasticity of, xiii. 484.—Action of fatty matters on vulcanized, 485.
- Indicators, Professor Moseley's steam-engine, v. 285.
- Harbours, Sunderland, wave-trap at, viii. 193, 200, 202.—Newhaven, xii. 17.
- Lighthouses, &c. Liability of a construction on submerged rocks to be injured by a wreck being driven against it, ix. 193.
- Locomotive engines worked more expansively than marine engines, xii. 425.
- Marine engines, employment of high-pressure steam, working expansively, in, viii. 305.—Perfecting the use of steam in ordinary marine engines, xviii. 280.

RUSSELL.

Naval construction, &c. English and American ship-building, xiv. 413.—Mechanical construction of the 'Warrior,' the 'Black Prince,' the 'Resistance,' and the 'Defence,' xx. 416.—Qualities required in iron-plated ships-of-war, 419.—Government experiments on iron plates, 421.—Quality of iron plates best able to resist the impact of shot, 423.—Construction of vessels-of-war having special qualifications for definite duties, 423.

North Sea, tides in the, and in the Frith of Forth, xx. 341, 346.

Public works, legislative interference in the construction of, ix. 181.

Pump valves, concussion of, xii. 456.

Railway, atmospheric, iv. 147, 149.—Relation between the useful effect and the power employed, 264.—As to attaining speed with the locomotive and on an atmospheric line, 277.—Resistance to be overcome by railway trains drawn by the atmospheric system, 285.

Railway inclines, experiments on, vii. 305, 318.

Railway trains, resistances to, as to determining the amount of, and analysis of experiments, v. 411, 421.—Mode of conducting experiments for ascertaining, vii. 294, 322, 326.

Railways, experiments on traction on, v. 286.—Table of results, 287.—Analysis of the various elements of resistance, 287.—Table constructed on the principles stated, 288.—Experiments for determining the traction on railways, and on board vessels, 289.—Modifications in the terms of granting railway concessions in Portugal, xviii. 19.

Rivers and estuaries. Phenomenon of the breaking 'bore' in the river Severn, v. 310.—System of spurs on the Dee, in Cheshire, vii. 244.—Effect of long oblique weirs for improving the régime of a river, and plan adopted in the Clyde, 245.—Principle to be kept in view in the improvement of channels and estuaries, 365.—Theory of tidal rivers and running streams, viii. 329.—Relative expediency of improv-

RUSSELL.

ing a tidal river, of making a canal, or of damming up a river and introducing locks, x. 291.—Improvements of river Clyde, 292.—Works for improving the harbour at Newhaven, formed by the outfall of the river Onse, xii. 17.—As to treating a river by groynes at right angles with the channel, or by training walls parallel to the banks, 17.—River Orwell, the improvements of rivers generally, and scour of the flood tide compared with that of the ebb tide, xx. 16.

Screw-piles, applicability of, for forming an open breakwater, vii. 142.

Sea defences, relative advantages of vertical, or sloping walls, vii. 414.—Angle with the coast at which groynes should be placed, viii. 202.

Sea-light tower, proposed circular wrought-iron, xv. 15.—Difficulty of providing adequate moorings, 16.

Sea-walls. Most appropriate slopes, or forms for, vi. 129.—Effect of vertical walls, 132.—On the coast near Edinburgh, vii. 196.

Shingle, movement of, vi. 133.

Ships and steam vessels. Advantages of employing a smaller number of large ships, rather than a greater number of small ships, for long voyages, xiii. 50.—Traffic must mainly determine the proportions of the ship, 51.—Vessels for the Australian, or Indian voyage, examined commercially, and their mechanical strength, 52.—Resistance of large vessels to waves, 52.—Impact of waves upon ships, 53.—Application of auxiliary power for long voyages, xiv. 410.

Steam boilers. "On certain points in the construction of marine boilers," xi. 390.—Remarks, 403.—Combustion of fuel under boilers, and proper position for greatest heat, especially in marine boilers, 403.

Steam navigation, &c. Advantages of disconnecting the engines from the paddle-wheels in steam-vessels, iv. 176.—New law of measurement of tonnage, xiii. 61.—Mr. Wise's experiments with

RUTHVEN'S PROPELLER.

Melville's propeller, and calculation of a hundred voyages from India and China to England, xiv. 411.—Methods of lifting screw out of water, 412.—Adoption for long voyages of minimum auxiliary power, 413.

Tides. Mode of making tidal observations, v. 310.—General datum line, for tidal reference, throughout England, 311.—Captain Denham's observations of the mean between high and low water, 313.

Viaduct, iron, at Manchester, and use of Stirling's toughened iron, xi. 239.

Water, discharge of, results of a series of experiments, by overfalls, or weirs, x. 350.

Water, flow of, in rivers under certain conditions, v. 359.

Water, resistance to bodies moving in, and power expended in propelling vessels, xvi. 331, 352, 354.—Effect of the shape of a ship on the speed, 332, 353.—Want of experiments to determine the force required to drag a vessel of a given shape and size through the water at a given speed, 333.—Head resistance of a ship, including the friction of skin, 354.

Water-wheels, construction of, particularly with ventilated buckets, viii. 63.

Waves. Power of translation of the tide-wave, vii. 363.—Generally two sets of waves in a storm, xiii. 54.

Working classes, comparison of, in different countries, in point of education, &c., xi. 63.

RUTHVEN'S PROPELLER.

"An account of the deep-sea fishing steamer 'Enterprise,' with Ruthven's propeller." By D. K. Clark, xiii. 370.—In this propeller nothing to interfere with the fishing nets, 370.—Chief dimensions of the vessel and of her machinery, 371.—Details of the propeller, 371.—Vessel can be steered by the nozzles, in case of the rudder being lost or disabled, 371.—Results of trial trips, 371.—Sources of loss of power, 373.—Percentages of useful effect of Ruth-

RUXTON.

ven's propeller, Appold's pump, and Barker's mill, 373.—Ratio of area of propulsion to immersed section, 374.—Advantages of this form of propeller for large vessels, 374.

Abstract of discussion. Similar system noticed by Benjamin Franklin, attempted by Sir I. Brunel, and tried by Mr. Bidder, 374.—Reasoning in the Paper at variance with the experiments, and with the laws of hydraulics, 374.—Reply, that if engine-power is consumed in getting the water up to the speed of the vessel, then an equal amount is not required to expel the water, 376.—Situations in which such a propeller may be found serviceable, as for example, for the Metropolitan Fire Brigade floating engines, 377.—Statements in the Paper, as to the useful effect, misunderstood, 377.—Duplicate pressure of reaction due to the efflux of water through the side of a vessel at rest, lost sight of, 377, 378.—Ratio of useful effect to power employed, 378.—Similar method of propulsion tried, in 1848, by Mr. Purkie, 378.—Supposed loss of power, in communicating to the water the velocity of the vessel, 379.—Illustrations to show that the power required to communicate velocity to the water passed through the propeller, is not afterwards utilized, 380.—Inference from the experiments, that the pressure was double the hydraulic height due to the velocity, is incorrect, 380.—Useful effect can be expressed, simply by the difference of the power consumed, in giving to the water the speed of the vessel, and the power in expelling it, 381.—Unbalanced pressure of reaction, by the flow of water through the side of a vessel at rest, 381.—Remarks as to the formula, showing that the maximum useful effect is only half the power expended, 382.

Employment of, on canals, xiii. 212.

Ruxton's contrivance for retaining a false key in a lock, xiii. 267.

S.

SADASEWJEE.

SADASEWJEE, H. [Election, xx. 375.]

Safety drag, used on the Edinburgh and Dalkeith railway (Rankine, W. J. M.), iii. 284.

Safety-lamp. *Vide* COAL MINES, and MINES.

SAFETY VALVES.

Application of volute springs to, (Baillie, J.), xv. 28.

"Description of an improved form of safety valve, for steam boilers." By J. Fenton, xv. 33.—Old class of 'mush-room' safety valve, 33.—Application of ball-and-socket principle to, 33. *Vide* also LOCOMOTIVE BOILERS.

Parallel motion safety valve (Poole, J.), xix. 52.

Sal-ammoniac. *Vide* Ammonia.

SALE, Colonel. [Election, i. (1840) 75.]

Defences, national, safety of the country mainly dependent upon the strength of the fleet, and measures for the defence, or protection of London, xx. 494.

Piles, reasons for not using, ii. (1842) 64.

SALKELD, J. [Election, i. (1840) 28.]

SALTER, R.

Drainage of towns. Self-acting penstock, or flushing-machine, xvi. 43.

Saltwood tunnel, application of horse power to raising water from, (Simms, F. W.), ii. (1843) 112.

SAMUDA, J. [Election, ii. (1843) 105; Telford medal, iv. 3.]

Lock-gates, iron, iii. 256.

Railway, atmospheric. "The atmospheric railway," iii. 256.—Remarks, 269, 271, 274, 276, 282.

Screw propellers, iii. 81.

SAMUDA, J. D'A.

Defences, national. Description of ships best adapted to secure the defence of the country, and of armour plating most suitable for such ships, xx. 427.

Railway, atmospheric, iii. 272; iv. 143, 149.—Principles which govern the

SAMUEL.

speed, 266.—Experiments with No. 4 train, and conclusions drawn in Mr. Stephenson's report, 266.—Results drawn from the experiments, 275.—Distance traversed by locomotive engines before their maximum speed is attained, 276.—Amount of leakage from the tube, 276.—Concluding remarks, 288.

Railway trains, resistances to, modes of determining, and experiments on the Croydon and Great Western railways, v. 414.—Third mode of measuring the resistances, &c., given in Mr. Harding's paper, and on the difference in the results of Mr. D. Gooch, Mr. Harding, and himself, 423.—Applicability of the atmospheric railway for trying such experiments, 442.—Examination of Mr. Harding's XXIIIrd experiment, 424.—Proposed experiments on the Epsom line (atmospheric), 427.—Recorded results of the experiments, 431.

Water, resistances to bodies moving in. Effect of form upon the speed of a vessel through the water, xvi. 340.—Cube of the velocity the real measure of resistance, 341.

SAMUEL, J. [Election, viii. 273.]

Permanent way, advantage of fish-joints for connecting two rails together, and system of embracing the double T rail with longitudinal sleepers, without the use of chairs, or holding-down bolts, viii. 263, 268.—'Fishing-plates' used on German railways, and the difference between them, and the fished suspended joint, and the fished-joint chair, adopted on the Eastern Counties railway, xi. 277.—Use of cast iron, in place of timber sleepers, on railways, particularly the 'trough,' the 'cup,' and the 'cup-trough' forms, xviii. 426.—Comparative cost of the substructure for a single line of way,

SAMUEL.

of a 'cup-trough' sleeper road, and timber cross-sleeper road, for a period of twenty-one years, 428.

Samuel's cast-iron sleeper, xi. 255, 262.

— fish-chair, xvi. 234.—Cast-iron sleepers, with the rails bedded in timber, 248.

SAMUEL, L. W. [Election, xix. 546.]

Sand pumped up in sinking wells, the cause of casualties, ii. (1843) 57, 58.

— in Morecambe Bay, experiments to test the bearing power of the, and to determine the size and form of disc best adapted for a permanent foundation, xvii. 442.

Sand-springs, ii. (1842) 162.—Supply of water from, 192.

SANDERSON, C. [Election, xiii. 64.]

Permanent way. Duration of railway points and crossings, xiv. 435.—Permanent way of railways, xvi. 383.

SANDERSON, C. (Sheffield). [Election, xv. 281.]

SANDERSON, G. S. [Resignation, viii. 10.]

SARTORIUS, Admiral Sir G. R.

Artillery, improvements in, and small-arms, as well as in projectiles, xx. 435.

Defences, national. Report of the Commissioners appointed to consider the defences of the United Kingdom, xx. 435.—Systems of defence not noticed by the Commissioners, including coast rail, and tram road, the arming of the mercantile marine, and the construction of steam rams, 436.

Ships and steam vessels. 'Warrior' and 'Gloire,' xx. 430.—Steam rams, 434.

SAUNDERS, G. H. [Election, vii. 184; memoir, xvii. 105.]

SAUNDERS, T.

Paving Boards, administration of, ix. 228.
Wind and current charts, value of, xiv. 410.

SAUNDERS, W. [Election, i. (1838) 84.]

SAUNDERSON, G. S. [Election, i. (1840) 68.]

SAUVAGE, M.

Screw propeller, iii. 73.

SAWARD, G.

Telegraph cables, causes of failure in submarine, xx. 77.—Atlantic cable, 78.
—Red Sea cable, 79.—Rangoon (Malta-

SCAFFOLDING.

Alexandria) cable, 80.—Respective merits of india rubber and gutta percha as insulating media, 80.

Sawing-machine, for deal planks, description of an improved plank frame for (Hick, B.), i. (1841) 97.

—, for cutting railway bars (Glynn, J.) i. (1839), 51.

Saw-mills, actuated by water-wheels and by the vanes of wind-mills, existed at a very early date, xvii. 17.—Circular saws of doubtful origin, 17.—Successive patents for the band-saw, 18.—Reciprocating, circular, and band-saws, 21.—Silent friction-pall, for giving motion to the timber in reciprocating sawing, 21.—Muley saw introduced in the United States, 21.—Revolving wedge for relieving the saw of the friction of the wood, 21.—Appliances for cross-cutting large balks, 23.—Saws for cutting ships' timbers, in curved forms, 25. *Vide also* MACHINERY.

Saw-teeth, forms of, xvii. 23.

SAWYER, T. S. [Watt medal, xviii. 174.]

Machinery. "On shearing, punching, riveting, and forging machinery," xvii. 173.

— "On the self-acting tools employed in the manufacture of engines, &c.," xvii. 176.

SAYCE, W. [Election, vi. 297; memoir, xx. 166.]

SCAFFOLDING.

"Account of the scaffolding used in erecting the 'Nelson column,' Trafalgar-square." By T. Grissell, iii. 203.—Squared timber for scaffolding, 203.—Comparative expense of the new and the old systems of scaffolding, 205.

Discussion.—Allen, J., 216.—Brenner, J., 213.—Brunel, Sir M. I., 216.—Colthurst, J., 209.—Fowler, C., 208.—Gale, —, 214.—Giles, F., 208.—Grissell, T., 207.—Harrison, J., 207.—Hawkins, J. J., 209.—Nicholson, —, 206.—Pasley, Lieut.-Gen. Sir C. W., 211.—Rendel, J. M., 209.—Bennie, G., 207.—Smith, O. H., 208, 209.—Thomson, J., 214.—Walker, J., 211, 214.—Wicksteed, T., 214.

SCALE.

"Description of the system of scaffolding, employed at Paris, for the repairs of public buildings, obelisks, &c., and of a machine for raising bricks, and other building materials." By P. Journet, iii. 218.

Discussion.—Grissell, T., 222.—Walker, J., 222.

"Description of the method employed for repairing a chimney 120 feet high, at the cotton mill of Messrs. Couper, Glasgow." By J. Colthurst, iii. 223.

Scale, double offset plotting, xviii. 404.

SCAMP, W. [Election, viii. 164.]

Caisson, sliding, at Keyham dockyard, xiii. 456.

SCANLAN, M.

Water supply. Chemical analysis of chalk and sand waters, ii. (1843) 163.

Scantlebury's clack, iii. 39.

SOHAFFHAUTL, Dr. C. [Election, i. (1841) 63; Telford medal, ii. (1842) 7.]

Beams. "Remarks on the position of the neutral axis of beams," iii. 248.

Cements (White, G. F.), xi. 508.

Photometer. "Description of a new universal photometer," i. (1841) 101.

Steam boilers, explosions of. "On the circumstances under which the explosions of steam boilers generally occur, and on the means of preventing them," i. (1841) 103.

Schultz' calculating-machine, explained by Mr. Babbage and Mr. Gravatt, xvi. 225.

— difference engine, explanation of some detailed diagrams of, illustrating Mr. Babbage's mechanical notation, xv. 497.

School-slates, frames of, machinery for the conversion of logs of American birch into the, xvii. 41.

Schulthess' (Dr.) electro-magnetic engine, xvi. 389.

SCORSEBY, Rev. Dr.

Ships for long ocean voyages, and proportions of, in connection with their rate of sailing (Manby, C.), xiii. 56.

Waves in the Atlantic (Henderson, A.), xiii. 34; (Manby, C.) 55.

Scott, Commander R., R.N.

SCOTT.

Artillery, construction of, rifling of the existing cast-iron service guns, and mode in which new guns should be cast, xix. 366.—Converting the existing stock of cast-iron guns into efficient rifled ordnance, xx. 427.

Defences, national. Experiments with armour-plates of various thicknesses, for the fortification of ships-of-war, and for defensive purposes, xx. 426.

Naval construction, &c. Advantage of concentrated broadside power in naval warfare, xx. 426.

Scott, C. W. [Election, xx. 191.]

Scott, J. [Election, iv. 211.]

Scott, M. [Election, vii. 75; Telford medal, xix. 155, 193.]

Breakwaters and piers. "Description of a breakwater at the port of Blyth; and of improvements in breakwaters, applicable to harbours of refuge," xviii. 72.—Remarks, 150.—Difference between the Blyth breakwater and the wooden piers in the river Wear, the caissons at Genoa, and the cones at Cherbourg, 150.—Stability of different forms of breakwaters, 151.—Calculation respecting the cost of the Portland breakwater, 153.—Comparative cost of breakwaters constructed on the old and the new systems, with Tables showing the rate of progress and cost, annually, and details of the quantities and prices, 153.—Table showing the cost of breakwaters, 161.

— "On breakwaters," Part II., xix. 644.—Remarks, 657.—Situation of the Blyth breakwater, 657, 672.—Proposed form of breakwater, 670.

Coals, arrangements for the shipment of, at the Tyne docks, xviii. 509.

Hydraulic apparatus, application of, for hoisting goods in the warehouses at Liverpool, xviii. 511.

Piles, driving, xviii. 509.—Use of land-tie piles in the quays at the Victoria (London) and the Tyne docks, 511.

Timber. Ravages of marine worms upon timber, particularly at Memel, and preservative process of creosoting, xviii. 437.

SCOTT.

Weir upon the river Severn, at the Upper Lode, near Tewkesbury, xix. 589.

SCOTT, P. B. [Election, i. (1839) 49; resignation, xiii. 194.]

SCOTT, W. B. [Election, xv. 47.]

Screw colliers. *Vide* COLLIERIES.

Screw-cutting, Shanks & Co's method, ii.

(1843) 144.—Cutters acting during the incursion as well as the excursion of the slide, 145.—Similar machine invented by Maudslay, 145.—Whitworth's screwing dies, 145.

SCREW-JACK.

"Description of a traversing screw-jack."

By W. J. Curtis, i. (1840) 60.

"An universal screw-jack." By G. England, i. (1840) 60.

Screw moorings (Mitchell's), use of, for proposed circular wrought-iron, sea-light tower, xv. 13.

Screw piles, Mitchell's, ii. (1842) 150.—

Use of, for lighthouses, and for the foundations of other works, x. 319.

— and moorings (Mitchell, A.), vii. 108.

Vide also FOUNDATIONS, Submarine; and LIGHTHOUSES.

SCREW PROPELLER.

"On the dimensions and performances of the 'Archimedean steamer.'" By G. Rennie, i. (1839) 70.—Dimensions and performances of the 'Archimedes,' 70.—Size and position of the large and small screws, 70.—Dimensions of the vessel, 71.

"Account of some experiments on a vessel called the 'Liverpool Screw,' fitted with Grantham's engines and Woodcroft's screw propeller." By J. Grantham, iii. 71.

Discussion.—Braithwaite, F., 83, 88.—Cottam, G., 86.—Cowper, E., 81.—Farey, J., 77.—Galloway, E., 75, 80, 84, 85, 86.—Grantham, J., 82, 85.—Hawkins, J. L., 84.—Homersham, S. C., 88.—Jordan, J. B., 88.—Norman, M., 78, 81.—Pasley, Lieut.-Gen. Sir O. W., 86.—Perkins, C., 85.—Rennie, G., 72, 76.—Samuda, J., 81.—Simpson, J., 88.—Smith, J., 77.—Walker, J., 85, 88.

History of the invention (Rennie, Sir J.), v. 97.—Advantages of the screw pro-

SEA DEFENCES.

pellor as an auxiliary power, vi. 21; (Field, J.), vii. 42.

Means of lifting the screw out of water, xiv. 879, 402, 412.

Vide also SHIPS and STEAM VESSELS; and STEAM NAVIGATION.

SCREWS.

"On an uniform system of screw threads."

By J. Whitworth, i. (1841) 157.—Characters and conditions, 158.—Want of uniformity, 158.—Selection of a standard, 158.—Table of pitches for angular threads, 159.—Depth of thread and calculation thereof, 159.

Discussion.—Field, J., 160.—Seaward, S., 160.—Walker, J., 160.

SEA DEFENCES.

Dymchurch wall. "Account of the Dymchurch wall, which forms the sea defences of Romney marsh." By J. Elliott, Jun., vi. 466.—Early history of the marsh, 466.—Construction of Rhee wall, 469.—Mr. Rennie's report in the years 1803-4, 471.—Messrs. Elliott's report in the year 1837, 473.—Mr. Walker's ditto, 473.—Description of the new works, 474.—Average cost, 476.—Measures adopted to prevent the shifting of the shingle, 477.

Discussion.—O'Brien, Capt. D., 478.—Redman, J. B., 481.

Dymchurch wall (Green, J.), vii. 194 (Borthwick, M. A.), 195.

Effect of storms upon. "Account of the effect of the storm of the 6th of December, 1847, on four sea walls, or bulwarks, of different forms, on the coast near Edinburgh; as illustrating the principles of the construction of sea defences." By W. J. M. Rankine, vii. 186.—Sea wall of the Leith branch of the Edinburgh and Dalkeith railway, 187.—Ditto on the turnpike road between Newhaven and Trinity, 189.—Ditto of a portion of the Edinburgh, Leith, and Granton railway, 190.—Ditto, at and near Granton, 190.—Efficiency of the surface of a wall to resist the action of the waves, 190.—

Discussion.—Bateman, J. F., 198.—Borthwick, M. A., 195.—Brunel, I. K.,

SEA DEFENCES.

- 193.—Buckland, Dr., 202.—Green, J., 194.—M'Clean, J. R., 201.—Murray, J., 199.—Paaley, Lieut.-Gen. Sir C. W., 192, 198.—Rankine, W. J. M., 199.—Rendel, J. M., 196, 198.—Russell, J. S., 196.—Smith, C. H., 200.—Thomson, J., 197.—Walker, J., 202.
- Helder, works at, (Macneill, Sir J.), ii. (1842) 128.
- Peat moss. "On sea defences constructed with peat moss." By the Hon. M. Stuart, i. (1841) 140.—Different uses of peat moss, 141.—Warping silt with whin, or gorse kids, 141.
- Penmaen Mawr. "Account of the sea-walls at Penmaen Mawr, on the line of the Chester and Holyhead railway." By H. Swinburne, x. 257.—Description of the terrace beneath the steep slope of Penmaen Mawr, 257.—Covered way along the first portion, 257.—Viaduct for second length of, 258.—Walls for third and fourth lengths, 259.—Profile of the beach, 259.—Original design for the main sea wall, 260.—Extract from specification as to coursed walling, 261.—Curved section first adopted, 262.—Coursed walling abandoned, 263.—Mode of carrying on the work, 263.—Working section of main sea wall, 265.—Gale of the 12nd October, 1846, and its effects on the works, 267.—Average section of main sea wall, as actually built, 269.—The breakwater and terrace in front of the wall, 270.—Details of the viaduct, 272.—Its cost compared with the best sample of the sea wall, 273.—Proposed fore-shore to be faced with ashlar, 273.
- Discussion.—Cubitt, Sir W., 276.—Lloyd, J. A., 277.—Moorsom, Capt. W. S., 275, 276.—Parke, W., 276.—Rennie, G., 276.—Stephenson, R., 274, 276.
- Sea weed and peat moss used for constructing, (Macneill, Sir J.) i. (1841) 132.
- Ulverstone and Lancaster railway. "On the construction of the sea embankments, across the estuaries Kent and Leven, in Morecambe Bay, for the Ulverstone and Lancaster railway." By J. Brunlees, xiv. 239.—Antiquity of art of

SEAWARD.

- forming, 239.—Description of Morecambe Bay, 239.—Details of different embankments, 240.—Force and action of the waves, tides, and currents of the sea, 243.—Best form of sea slopes, 244.
- Discussion.—Brogden, J., Jun., 249.—Brunlees, J., 246, 249.—Hemans, G. W., 247.—Simpson, J., 250.
- Vide* also BREAKWATERS; CANALS, Great North Holland; DOCKS, Sunderland; and HARBOURS OF REFUGE.
- Sea lights. *Vide* BEACONS, FLOATING; and BUOYS, BEACONS, and SEA LIGHTS, &c.
- Sea walls. *Vide* BREAKWATERS; CANALS, Great North Holland; HARBOURS OF REFUGE; and SEA DEFENCES.
- Sea water, action of, on an iron heel-post (Mushet, D.), i. (1840) 3.
- has no perceptible action upon lead, brass, or copper, however long they may be immersed, ix. 194. *Vide* also IRON; and METALS, Corrosion of.
- chemical composition of, xiv. 519.
- Seaton's modification of the bridge-rail, xvi. 243.
- longitudinal timber permanent way, without chairs, xx. (280) 23.
- SEAWARD, J. [Memoir, xviii. 199.]
- Marine engines. "On the employment of high-pressure steam, working expansively, in marine engines," viii. 304.
- Steam engines. "Remarks on the comparative advantages of long and short connecting rods, and long and short stroke engines," i. (1841) 53.
- SEAWARD, S. [Member of Council, i. (1841) 52; ii. (1842) 51; Telford medal, 7; memoir, (1843) 11.]
- Bridges, suspension, oscillation of, i. (1841) 80.—Alterations made in that at Montrose, 127.
- Naval construction, &c. Trenails for ship-building, i. (1841) 86, 87.
- Screws—threads, uniform system of, i. (1841) 160.
- Steam, action of, i. (1840) 78; (1841) 152.
- Steam boilers, explosion of, particularly at the Polgooth, and the Harlam mines, i. (1841) 113, 114.
- Steam navigation, &c. "Upon the application and use of auxiliary steam

SECTIO-PLANOGRAPHY.

power, for the purpose of shortening the time occupied by sailing ships upon distant voyages," i. (1841) 68.—Remarks, 68.—Explanation of his table of velocities of steam-ships, 68, 72.—American steam-boats, 73.

— "Supplementary account of the use of auxiliary steam-power, on board the 'Earl of Hardwicke' and the 'Vernon' Indiamen," i. (1841) 129.

Timber, kyanizing, ii. (1842) 85.

Wind, force of, exerted at regular intervals, i. (1841) 79.

Sectio-planography, ii. (1842) 155.

Sedgwick's (Prof.) quotations from, works, as to cleavage of primary rocks, xv. 70.

SELBY, F. [Election, xx. 106.]

SELBY, G. [Election, v. 478.]

SELBY, G. T. [Election, xvi. 226.]

SELLA, C. [Election, xi. 68.]

Semaphore telegraph between London and Dover, and to Portsmouth, xi. 301.

Semple's treatise on building in water, xvi. 432.

Sevastopol, docks at, iron gates for (Shears, W.), vi. 47.

Sewage and Sewage manure. *Vide DRAINAGE OF TOWNS*; and *RIVER WANDLE*.

SEWELL, J. [Council premium, xiii. 127; election, 421.]

Bells. Fracture of the first Great Bell at Westminster due to the meeting of the waves of sound, xix. 17.

Fuel. Evaporating power of different fuels, xiv. 15, 28.

Locomotive boilers. "On locomotive boilers and on fuels," xii. 432.

Metals, fracture of, xiii. 471; xix. 16, 17.

Railway axles, fracture of, xiii. 471; xix. 16.

Steam boilers, explosions of, xiii. 471.—Injury caused to the plates of boilers by the vibratory waves of expansion and contraction, xix. 16.

Sewer, description of a new, in the valley of the Cowgate, Edinburgh (Smith, G.), i. (1841) 157.

Sewerage of towns. *Vide DRAINAGE OF TOWNS*.

Sewer-grate traps, Austin's and Jennings', xiii. 295.

SHERRARD.

Sewers. *Vide DRAINAGE OF TOWNS*; and *WATER, FLOW of*.

Shafts, hollow, preferred to solid, ii. (1843) 108.

— of mines, cost of sinking, vi. 192.

—, screw and paddle, return of accidents to, in the Peninsular and Oriental Steam Navigation Company's fleet, xviii. 344. *Vide also IRON*.

SHAND, J. [Election, xvii. 52.]

Shanks and Co.'s lathe for cutting screws, ii. (1843) 144.

Shaping-machines, American, xvii. 30.

SHARPE, M. [Election, xiv. 491.]

SHARPE, R. [Election, xix. 489.]

SHAW, E. W. [Election, xvii. 52.]

SHAW, H. R. [Election, xix. 546.]

SHAW, J. C. [Election, i. (1839) 51; resignation, xiii. 184.]

SHAW, W. M. [Election, xvi. 43.]

SHEARS, W. [Election, iv. 291; Telford premium, vii. 3.]

Docks. "Description of the iron gates for the docks at Sevastopol, and of the machinery used by Messrs. G. and J. Rennie in their construction," vi. 47.

Sheathing for ships. *Vide SHIPS AND STRAM VESSELS*.

SHEILDS, F. W. [Election, xv. 348.]

Shell, segment, used with the Armstrong artillery, xix. 407.

—, Swedish percussion, xix. 378.

SHELLEY, C. P. B. [Election, xvi. 458.]

SHEPHERD, —.

Pier, Mill Bay, raft of creosoted timber at, ix. 50.

SHEPHERD, Captain.

Sea-light tower, proposed circular wrought-iron, in place of present light-ships, xv. 21, 23.—Advantage of present light-ships, 22.—Cables of light-ships, 22.

Wrecks, causes of, on British coasts, xv. 22.

Shepherd and Button's submarine telegraph cable, xi. 379.

SHEPPARD, F. A. [Election, xiii. 64.]

SHEPPARD, R.

Beams. Experiment for ascertaining the effects on a beam under pressure, xvi. 81.

SHERRARD, J. C. [Election, i. (1840) 50.]

SHERIFFS.

SHERIFFS, J. [Election, x. 298.]

Shield used at the Thames tunnel, ii. (1843) 80.

Shingle, motion of, ii. (1842) 129; vi. 131, *et seq.*, 144; vii. 199, 344; viii. 204; xi. 208, *et seq.*; xii. 520. *Vide also* CHESEL BANK, and COASTS.

Ship-building in America and in England, xiv. 408, 413.—In the public establishments, xix. 460.

— in iron, vii. 35, 39; xiii. 35.

SHIPS AND STEAM VESSELS.

American steamers (Blunt, —), i. (1837) 21.

Archimedean steamer. "On the dimensions and performances of the 'Archimedean' steamer." By G. Rennie, i. (1839), 70.—Size and position of the large and small screws, 70.—Dimensions of the vessel, 71.

'Great Britain.' "Description of the 'Great Britain' iron steam ship; with an account of the trial voyages." By T. R. Guppy, iv. 151.—Observations on the 'Great Western,' 151.—Principal dimensions and weight of the 'Great Britain,' 152.—The water-tight bulkheads, 154.—Experiments on the performances of the screw propeller in the 'Archimedes,' 155.—Application of screw to the 'Napoléon,' 158.—Screw of the 'Great Britain,' 158.—Engines of ditto, 159.—Pitched chain, for connecting the driving machinery with the screw shaft, 160.—Screw shaft, 160.—Boilers, 161.—Account of several trial trips, 162.—Summary of the voyage from Bristol to London, January, 1845, 163.—State of the ship during the gale of 24th January, 1845, 164.

Discussion.—Barnes, J., 165, 170.—Braithwaite, F., 176.—Crispin, Capt., 172.—Curtis, J. G. C., 173.—Field, J., 173.—Guppy, T. R., 166, 169, 176.—Hoeken, Capt., 166, 167, 169, 175, 177, 178.—Miller, J., 167.—Napier, Capt. Sir O., 166, 167, 168.—Pim, J., 177.—Rennie, Sir J., 170, 175, 180.—Russell, J. S., 176.—Smith, F. P., 170, 173, 175, 178.—Stephenson, R., 170.—Taylor, P., 170.

SHIPS AND STEAM VESSELS.

History of. Date of the first steamer running to Gravesend (Redman, J. B.), iv. 223.—Historical account of the progress of steam navigation (Rennie, Sir J.), v. 81; vi. 21.

'India.' "Description of the steam ship 'India,' with a table of the proportions of large steam ships." By Lieut. E. N. Kendall, i. (1840) 50.

Iron barque 'Josephine.' "Account of the iron barque 'Josephine,' of Liverpool, launched January, 1845." By Capt. Masters, vi. 297.—Dimensions of the hull, materials, spars, &c., 298.—Her sailing qualities, 302.—Iron and wood vessels compared, 304.—Compositions used for preventing corrosion, 305.—Errors and differences in the compasses, 306.—Corrections for ditto, 311.—Loss of 'Great Britain' owing to ditto, 312.—Appendix, abstract of the journal from Matanzas to London, 314.—Ditto, from Liverpool to Lisbon, 315.

Iron-plated, conditions required in, (Annual Report), xx. 120.

Mechanical contrivances for working, as to supplying the want of, (Simpson, J.), xv. 24.

Repairing platform for. "A description of a new arrangement for raising ships of all classes out of water for repair; proposed to replace the graving-dock, or the patent slip in certain situations; with observations upon the other methods used at different periods for this purpose." By R. Mallet, ii. (1842) 135.

Discussion.—Gordon, A., 137.—Hawkins, J. I., 136.—Palmer, H. R., 136.—Rendel, J. M., 136.—Walker, J., 137.

'Sarah Sands.' "Description of the 'Sarah Sands' and other steam vessels fitted with direct acting engines and screw propellers without intermediate gearing." By J. Grantham, vi. 283.—First outward voyage, 288.

Discussion.—Field, J., 291, 292, 297.—Grantham, J., 289, 296.—Grantham, R. B., 293.—Laming, J., 294.—Rennie, G., 292.—Smith, Capt., 294.—Woodcroft, B., 293.

SHIPS AND STEAM VESSELS.

Sheathing for. "On lead sheathing for ships." By J. J. Wilkinson, i. (1841) 82.

— "An historical account of wood sheathing for ships." By J. J. Wilkinson, i. (1841) 98.—Notice of the milled lead sheathing, 99.

— "An historical account of copper sheathing for vessels." By J. J. Wilkinson, ii. (1842) 65.—Importation, 65.—Relative qualities of foreign and British, 65.—First used on the 'Alarm' frigate, 66.—Decay of, 66.—Alloy of zinc necessary to prevent decay, 66.—Quantity of, used for a ship of 120 guns, 66.—Sir Humphry Davy's experiments on the oxidation of, 66.—Collected so much sea weed as to impede the sailing of vessels, 66.—Gradual progress of, 67.—Patents for, 67.—The number of ships on which it is used in the Thames and at Liverpool, 67.—Entirely neglected for collier ships, 67.

Discussion.—Bethell, J., 68.—Hawkins, J. I., 68.—Horne, J., 68.—Lowe, G., 67.—Oldfield, Lieut., 68.—Parkes, J., 68, 69.—Taylor, J., 69.

Sheathing for. "On iron sheathing, broad-headed nails, and inner sheathing for ships." By J. J. Wilkinson, ii. (1842) 168.—Corrosion of, 168.—Patents for, 168.

— Experiments for preventing oxidation (Galloway, E.), iii. 87. *Vide* also METALS.

'Vanguard.' "Description of the 'Vanguard' iron steam vessel, after being ashore on the rocks in the cove of Cork." By J. Grantham, iv. 302.—Particulars of her construction, and dimensions of various parts, 303.—How the accident occurred, 303.—Her position after it, 303.—The extent and nature of the damage, 304, 305.—The mode employed to get her off the rock, 304.

Discussion.—Guppy, T. B., 306.—Mallet, R., 306.—Miller, J., 305.—Vignoles, C., 306.

Velocity of steam vessels, results of ex-

SIDNEY.

periments for ascertaining the, (Bilder, G. P.), v. 278, 279.

Vide also COLLIERIES; COMBINED VAPOUR ENGINE; DEFENCES, NATIONAL; SREW PROPELLER; and STEAM NAVIGATION.

Shipwreck, causes of, report from the Select Committee of the House of Commons, in 1836, vii. 366.

Shipwrecks on British coasts, xv. 20, 22.

SHORT, Lieutenant W. D. A. R., B.E. [Election, x. 293.]

'Shunt' gun, muzzle-loading, the projectile to be employed in it, the development of one of the grooves, and the breech-closing apparatus arranged so as to work from the side, in such a way that the gun could not be fired until the process of closing the breech had been perfected, xx. 478.

Shuttles of water-wheels, ii. (1843) 64.

SIBLEY, O. K. [Election, v. 248; memoir, ix. 106.]

SIBLEY, G. [Election, ix. 182.]

Public works in India. Extent of irrigation canals executed under native rule in Bengal, xvii. 524.—Extension of, 525.—Great want of district roads, 526.—Suggestion that the district road-funds should be applied as guarantees for branch lines of railway, 526.—Importance of a good system of village roads, 527.—Railways at present in course of construction, and the causes leading to delay in their execution, 527.—Extent of the works on the East Indian railway, 528.

Rivers and estuaries, embanking, with view of preventing inundation, xvii. 525.

SIBLEY, R. [Member of Council, i. (1841) 52; ii. (1842) 51; (1843) 67; iii. 66; iv. 62; memoir, ix. 101.]

Asphalte, Seyssel, ii. (1843) 96.

Embankment, Hanwell, iii. 168.

Metals, corrosion of, i. (1839) 34.

Roads, &c. "On the improvement of the roads, rivers, and drainage of the counties of Great Britain," i. (1841) 100.

SICH, H. W. [Election, xx. 292.]

SIDNEY, S.

SIEBE.

Patents. Whether the principle of granting a limited monopoly is the best mode of rewarding inventors, x. 215.—Cost of patents, 215.

SIEBE, A. Jun.

Diving apparatus, improvements in helmet, xv. 327, 345.—Close helmet, 346.—Improvements in air-pump, 347.

SIEBE, A. Sen. [Election, xvi. 46.]

Diving apparatus, improvements in helmet, xv. 327.

SIEMENS, O. W. [Telford medal, xiii. 127; election, 383.]

Air engines. "On the conversion of heat into mechanical effect," xii. 571.—Remarks, 591.—Dynamical theory of heat, 591.

Artillery, construction of, especially Krüpp's cast-steel gun, xix. 378.—Experiments and apparatus for determining the pressure upon the interior of a gun when fired, and the resistance of the atmosphere to shot, at different velocities, 379.

Electric telegraph. Arrangements of instruments and wires on lines in Germany, xi. 362, 377.—Pointing instrument, 362.—Line from Berlin to Hamburg, 362.—Town telegraph of Berlin, 363.—Printing instrument, or secretary, 363.—Advantages of underground line-wire, 365.—Means of discovering places of rupture, or of bad insulation, in underground line-wires, 366, 373.

Engines. Performances of Du Trembley's combined ether-engine, compared with an ordinary expansive steam-engine, and their relative merits examined from a theoretical point of view, xviii. 256.—Experiments for determining the latent heat of ether, 290.—His regenerative engine, xix. 480.

Ericsson's calorific engine, xii. 345.—Action of 'regenerator' in, 346, 591, 598.

Gas, leakage of, through mains, xvi. 320.

Machine for joining lead and other pipes, xviii. 405.

Steam, superheating, and experiments for determining rate of expansion, xix. 479.

SIEMENS.

—Mixing ordinary saturated with superheated steam, 480.

Telegraph cables, insulating, shielding, and submerging, xvi. 218.—Discovery, in 1846, by Mr. W. Siemens, of the non-conducting property of gutta-percha, 219.—Adoption, by the Prussian and other German governments, of the underground system of wires, 219.—Gutta-percha covered wire, deposited in the Bay of Kiel, in 1848, by Mr. W. Siemens, 219.—Means for counteracting the lateral induction, or electric charge of the wire, in long underground line-wires, 219.—Retardation of electric waves, in passing through long submarine cables, 219.—Means of accelerating the passage of an electric wave through a cable, 220.—Apparatus employed in laying the Mediterranean telegraph cable from Cagliari to Bona, xvii. 319.—Best form and materials for a submarine cable, 320.—Electrical condition of the Channel Islands cable, mechanical accidents which had occurred to it, and plan of enclosing the electric wires when crossing rivers or bays, xx. 53.—Red Sea cable, observations on the electrical condition of the cable during submersion, and necessity for establishing a complete system of testing before a cable was shipped, 54.—Method of testing employed by Messrs. Siemens, 55.—Testing of the Rangoon (Malta-Alexandria) cable, 56.—Loss of insulation, indicating an increase of temperature, after being shipped, and cause of the generation of heat, 57, 72, 90.—Outer covering of cables, and insulating medium, 59.

Water-meters, xiii. 431.—Chief desiderata for high-pressure, xvi. 51.—His 'inferential' measurer, 51.—Results of its use, 52.—Piston and diaphragm meters, 53.—Mr. Jopling's piston-meter, 53.—Objections to his form of meter, xvi. 63.

Water supply. Waste of water in large towns, xviii. 397.

SIEMENS, Messrs. E. W. and O. W.

SIEMENS' WATER-METER.

- Chronometric governor, description of their (Woods, J.), v. 255.
- Siemens' water-meter, xiii. 426.
- Siemens' and Adamson's water-meter, xiii. 426.
- Siemens, (C. W.), regenerative engines, results obtained from, xvi. 15.
- Sight tubes for marine boilers, ii. (1842) 154.
- Signal telegraph, electro-magnetic, ii. (1843) 181.
- Signal whistle for railways, and for other purposes, iv. 150.
- Signals, railway, the use of maroons for, i. (1841) 116.
- , —, self-acting (Curtis, C. B.), ii. (1842) 186.—Ditto, Gibson's, xvii. 51.
- , —, accidents arising from inattention to, 444.
- , —, want of uniformity in the description of, in general use, and in the method of working them, xvii. 480.
- , surveying, i. (1837) 19.
- Silicate of alumine, ii. (1843) 154.
- of potash, used to render timber un-inflammable, ii. (1842) 89.
- SILLIMAN, Professor.**
- Gold. Extract from his remarks as to gold districts of Virginia, U.S. (Hopkins, E.), xv. 69.
- SILVER, H. A.** [Election, xx. 258.]
- SIMMONS, Colonel J. L. A., R.E., O.B.** [Election, vi. 297.]
- Bridges. Strength of the Torksey tubular girder bridge, ix. 267, 274.—Wrought-iron girder bridges, xi. 237.
- Defences, national, xx. 487.—Presumed sufficiency of the fleet alone, unaided by land defences, to secure the shores from insult, 487.—England requires time to prepare and to develop her warlike resources, 488.—National defences never been considered, as a whole, by any special Commission, or Committee, 489.—Advisability of a limited number of ports only being fortified as bases of operation for the fleet, 489.—Fortifications of Portsmouth, Alderney, Dover, and the defences of the Medway and the Thames, 490.—Land forces should be concen-

SIMPSON.

- trated so as to cover the metropolis 492.—Necessity of preparing secure bases of operation for the army, 498.
- Permanent way, construction of, xi. 285.
- Cost of maintenance of, 295.
- SIMPSON, F. W.** [Election, i. (1838) 9; Telford medal, iii. 6.]
- Asphalte, i. (1838) 6.
- Brickmaking. "An account of the brickmaking at Blechingley tunnel, during the winter of 1840, and summer of 1841," ii. (1843) 145.—Remarks, 147, 148.
- Horse power. "Results of the application of horse power to raising water from the working shafts at Saltwood tunnel, on the South Eastern railway, in 1842" ii. (1843) 112.
- Roofs. "On the construction of flat roofs, with earthenware pots," i. (1838) 5.
- SIMPSON, W.** [Mémoir, xx. 167.]
- SIMPSON, J.** [Election, xi. 477.]
- SIMPSON, G.** [Election, i. (1841) 157.]
- SIMPSON, J.** [Member of Council, i. (1837) 15; (1838) 20; (1839) 27; (1840) 36; (1841) 52; ii. (1842) 51; (1843) 67; iii. 66; Vice-President, iv. 62; v. 142; vi. 46; vii. 56; viii. 44; ix. 91; x. 60; xi. 84; xii. 112; President, xiii. 123; xiv. 97.]
- Address, on taking the chair for the first time after his election as President, xiii. 190.—Early history of the Institution, 192.—Foreign railways in progress, 193.—British railways in progress, 193.—Maritime works in progress, 194.—Lighthouse upon the Bishop's Rock, off the Scilly Islands, 195.—Ditto upon the Gunfleet Sand, near Harwich, 195.—Praise due to Mr. F. P. Smith, for his steady advocacy of the practicability of screw propulsion, 196.—Public works on the Continent, 196.—Iron screw colliers, and Dr. D. B. White's water-ballast, 196.—On large ocean steam-ships, and facilities for coaling them on long voyages, 197.—Improvement of street paving in large towns, 197.—Patent

SIMPSON.

laws, 198.—Improvements introduced into water-works during the nineteenth century, 198.—Ditto in the drainage and sewerage of cities and towns, 199.—Land-drainage, and the question of outfall, 200.—Smoke nuisance, 201.—Extension of gas-works, and improvements in its manufacture and distribution, 202.

Aqueduct pipe crossing the Thames, from Putney to Fulham, xiv. 528.

Blasting under water, raft used for, at the West Hartlepool harbour and docks, x. 295.

Buoys, beacons, sea-lights, &c., means of improving, xv. 24.

Chalk, fissures in the, ix. 178.—Chalk as a water-bearing stratum, xiv. 93.

Civil and mechanical engineers. Necessity for a system of national scientific mining education, xii. 311.—Northern Institute of Mining Engineers, 311.

Colliers, iron screw, and Dr. D. B. White's water-ballast, xiii. 196.

Concrete wall at Seething Wells, xvi. 438.

Decimal coinage, &c., plan of, proposed by Mr. S. Richardson, xiii. 348.

Dock gates and caissons, tackle employed for, xiii. 463.

Drainage of land, and the question of outfall, xiii. 200.—Difficulties in obtaining outlets for land drainage, xix. 89.—Project for the drainage of low lands near Wareham, 90.

Drainage of towns, vii. 94.—Non-injury to iron pipe from sewage, xi. 419.—Objections to small sewers, with sharp gradients, &c., when made of earthenware pipes, or of thin hollow bricks, xii. 92.—Selection of the outfall of the London sewers, 93.—Proposals for pumping up the sewage of the metropolis, 93.—Successful use of iron pipe for a sewer, 94.—Sewerage of Hamburg, xiii. 81.—System of catch-water drains indispensable for the sewerage of London, 81.—Separation of the house-sewerage from the surface-drainage in the metropolis, 94.—Pipe-sewers, 94.—Comparative cost of brick-sewers and pipe-drains, 95.—Pumping

SIMPSON.

power required for raising the sewage matter of the south side of the Thames to a height of 30 feet, 100.—Drainage of the district south of the Thames, 111.—Maximum duty to be performed by the high-level intercepting sewer, and by the low-level sewers, 111.—Storage room of the present sewers, 112.—Mr. Harrison's project for the drainage of the district south of the Thames, 113.—Pumping scheme of Mr. Bazalgette, 113.—Improvements introduced in the drainage and sewerage of cities and towns, 199.

Embankments, formation of, and the slopes of cuttings, iii. 153.—Sea embankments, xiv. 250.

Engine-counters, vii. 72.

Engineering works, legislative interference in, ix. 244.

Fire-proof floors on Barrett's system, at the New Hotel, Carlisle, xii. 270.

Fires, means of extinguishing. Supplies of water in case of fires, iii. 322.

Foundations. Sinking of metal cylinders for artificial foundations and other purposes, iv. 249.—Foundation of iron viaduct at Manchester, xi. 234.

Furnaces, admission of air to, xiv. 17.—Prevention of smoke from boiler furnaces, 31.

Gas. Extension of gas-works, and improvements in its manufacture and distribution, xiii. 202.

Geology of the Isle of Wight, xiv. 93.—Study of geology in the field rather than in the lecture-room, xv. 74.

Girders, risk of overloading, xiii. 475.—Experiments for ascertaining direction of strains on girders, xiv. 490.

Harbours of refuge, necessity for the construction of, vi. 145.

Hydraulic machinery, air vessels for preventing concussion in, ix. 386.

Iron, cast, proper qualities of, to be used for castings exposed to sea-water, iii. 88.

Iron, wrought. Protecting wrought-iron work from influence of weather, xi. 240.

Lighthouse upon the Bishop's Rock, off the Scilly Islands, xiii. 195.—Ditto

SIMPSON.

- upon the Gunfleet Sand, near Harwich, 195.
- Manometer, new metallic, and other instruments for measuring pressures and temperatures, xi. 22.
- Meat, preservation of, ii. (1842) 83.
- Metals, corrosion of, i. (1839) 87.
- Mortar. Impurities in the chalk lime of London, x. 302.
- Patent laws, xiii. 198.
- Paving. Improvement of street paving in large towns, xiii. 197.
- Permanent way. Construction of railway switches and crossings, xiv. 442.
- Pier (new) at Hartlepool, for forming a harbour, vi. 145.—Pier at Southend, and means for preventing the attacks of the worm, ix. 43.
- Pipes, iron, porosity of, iii. 303.—Expansion and contraction in mains, xiv. 39.—Laying water-mains across and beneath the bed of a broad navigable river, 40.—Joints of water-mains, 41.
- Public works on the Continent, xiii. 196.
- Railways in progress on the Continent, xiii. 193.—In Great Britain, 198.
- Rainfall, amount of, in London, from the year 1820 to 1829 inclusive, xiii. 113.—Table of the instances of the fall of rain, amounting to more than half an inch within twenty-four hours, during the years 1851-52-53, 115.
- Rivers and estuaries. Effects of the tidal water in the Wear, vi. 278.—Works for the improvement of the Tees, vii. 246.—Experiments on the flux and reflux of the tide in the Thames, xiii. 94.—Effects of the floods of the Lee upon the lower reaches of the Thames, 251.—Rise and fall of the Wandle—its springs, tributaries, and pollution, particularly the flow, and fluctuations caused by the extension of land drainage, xx. 211.—Pollution of the Wandle by the sewage of Croydon, and from other sources, 232.
- Roads, different methods of macadamizing, xiii. 234.
- Roofs. Durability of iron roofs, especially when covered with galvanized iron,

SIMPSON.

- xiv. 265.—Great interest of discussion on iron roofs, 272.
- Screw propeller, application of the, to sailing vessels, xiv. 396, 406.
- Ships and steam vessels. On large ocean steam ships, and facilities for coaling them on long voyages, xiii. 197.—Want of mechanical appliances in the working of, xv. 23.
- Smoke, prevention of, xiii. 201, 415.
- Steam engines. Comparative merits of the single-acting engine and of the crank engine, for raising water, i. (1837) 81.
- Steam navigation, &c. Praise due to Mr. F. P. Smith, for his steady advocacy of the practicability of screw propulsion, xiii. 196.
- Timber, saturating, by pressure, ii. (1842) 82, 83.—Payne's process for preserving timber, ix. 48.
- Tunnels. Difficulties of sinking shafts in sand, xiii. 478.
- Valves. Suggestion of the conical concentric ring valve for large pumps, ii. (1843) 196.—Pump valves, 198.
- Viaducts, timber, for railways, xiv. 506.
- Water, discharge of. Experiments at Chew Magna, to ascertain the discharge from some reservoirs connected with the Bristol water-works, x. 350.—Ditto at Alnwick, through a pipe 18 inches in diameter, xiii. 118.
- Water, flow of, through pipes, xiv. 816.
- Water-meters, xvi. 59.
- Water supply from artesian wells, i. (1839) 62.—Chalk basin of London, ii. (1843) 163.—Depression of the water-level under London, ix. 178.—Variations in the quality of the water, 179.—Best time for gauging, and flow compared with the fall of rain, x. 331.—Water to be supplied from districts to the south and south-east of the metropolis, xiv. 94.—Supply of water to Bristol, and brief description of principal works, 218.—Depression of water in chalk districts surrounding London, 512.
- Water-works, Glasgow, ii. (1843) 186; cast-iron reservoir for, 140.—Covering reservoirs for water-works, xii. 269.—

SIMPSON.

- Improvements introduced during the nineteenth century, xiii. 198.
- Waves, motion of, and the result of their action, vi. 145.
- Wells. Report on the sinking of the well in the Hampstead-road (Mylne, R. W.), i. (1839) 62.—Sinking wells by means of the 'miser,' ii. (1842) 64.—State of Messrs. Truman's well, 193.—Filtration, (1843) 188.—Wells at Southampton and Chichester, 142.—Account of wells near London, 163.—Well at Hanwell, ix. 179.—Artesian well at Grenelle, xiv. 68.—Presence of sea-water in wells, 512.—Infiltration of sea water into springs, 523.
- SIMPSON, J., Jun. [Council premium, xiv. 105.]
- Smoke, prevention of. "On the prevention of smoke in engine-furnaces," xiii. 383.—Appendix, description of some of the smoke-consuming apparatus at present in use, with remarks, 390.—Remarks, 410.—Objections to the use of mechanical means for the prevention of smoke, in Manchester and neighbourhood, 410.
- SIMPSON, W. [Auditor, i. (1838) 20; (1840) 36.]
- SINGLAIR, A. [Election, xii. 206.]
- Railway inclines, mode of working, and reduction of, on the St. Helen's railway, x. 252.
- SINCLAIR, R. [Election, i. (1840) 22.]
- SINCLAIR, B. [Election, xvii. 410.]
- Axle-boxes, new system of, not requiring lubrication, and without liability to heating, xviii. 414.
- Permanent way. Mr. W. B. Adams' system of enabling the double-headed rail to be used without chairs, xviii. 426.—Durability of the creosoted, Burnetized, and unprepared sleepers used on the Eastern Counties railway, 433, 434.
- Railway breaks, especially Mr. Fay's and Mr. Newall's continuous breaks, xix. 518.
- Timber. Process of creosoting an effectual preservative against the ravages of the sea-worm at Lowestoft harbour, xviii. 438.

SLUICING.

- SINGLA, J. C.
- Lock-gates. "A new plan of construction of sliding gates for the entrance locks of docks, &c.," i. (1839) 78; (Murray, J.), xiii. 458.
- Sinking pits in the North of England, (Atkinson, R. T.), ii. (1842) 171.
- well at Meux's brewery, ii. (1842) 162.—At Reid's brewery, 164.—At Truman, Hanbury, Buxton, and Co.'s brewery (Davison, R.) 192.
- SLATE, A. [Election, iii. 101; Member of Council, xviii. 164; memoir, xx. 168.]
- Bridges, suspension, proportions of pin, head, and body of link for, viii. 279.
- Fuel. Use of coal, instead of coke, in engine-furnaces, xvi. 34.
- Furnaces, form and yield of blast, iii. 246.
- Geology. Deposits of drift in Staffordshire, iii. 134.
- Iron, cast. Use of hematite ore in South Staffordshire, iii. 246.
- Locomotive engines, relative economy of manufacturing, by railway companies and by private individuals, xi. 463.
- Railway, atmospheric, iii. 277.
- Ships and steam vessels. Proposed enlargement of vessels by Americans, xiii. 31.
- Slate formation in North Wales, xv. 67.
- quarries of Ffestiniog, xv. 64.
- Slates, not durable in London, i. (1839) 34.
- SLAUGHTER, E. [Election, xiii. 64.]
- Slaughter-houses, *Vide* ABATTOIRS.
- SLATER, J. M. [Election, xvii. 195.]
- Sleepers. *Vide* PERMANENT WAY; RAILWAYS; and TIMBER.
- Sliding rule, improved, xiv. 524.
- Slips, *Vide* CUTTINGS; EMBANKMENTS; and LAND-SLIPS.
- Sluice and lock at Ferraby for the Ancholme drainage, iv. 195.
- Sluice-gates of water-wheels, ii. (1843) 64.
- Sluice valve, Jennings', xii. 272.
- SLUICES.
- "Description of Chelson Meadow sluice." By T. Budd, ii. (1842) 62.
- Discussion.—Prior, J. C., 63.—Bendel, J. M., 62.—Walker, J., 63.
- Sluicing, xv. 437, *et seq.*

SMART.

SMART, M. K. [Election, xiii. 241; memoir, xvii. 104.]

SMEATON, J.

Cements, water, his experiments on. (Rennie, G.), xvi. 432.

Drainage of land. Extracts from his unpublished MSS. on, particularly that referring to the Deeping fens (Farey, J.), iv. 205.—His improvements in the draining of marsh lands (Rennie, Sir J.), v. 22.

Engineering works, his principal. (Rennie, Sir J.), v. 21.

Hydraulic engines. The first water-pressure engine in England supposed to have been erected by him (Taylor, J.), ii. (1843) 144.

Iron, smelting, on, with peat. Extracts from his MSS., i. (1839) 37.

Portrait presented (Burgess, A.), i. (1841) 13.

Power, animal, estimate of. Extracts from his MSS. (Farey, J.), i. (1839) 37, 50.

Steam engine, his improvements in the, (Rennie, Sir J.), v. 22.

Viaducts. His practice of making every third, or fifth, pier in a long bridge, or viaduct, an abutment, (Gravatt, W.), x. 240.

Water-wheels, theory of, (Mallet, R.), ii. (1843) 60.—Practice in filling the buckets, 63.—Velocity of water-wheels, 64.

Wind and water mills, his experiments and report on (Rennie Sir J.), v. 21.

Smeaton and Brindley's experiments on the discharge of water over a waste board, x. 332.

SMEATON, J. [Election, ii. (1842) 165.]

SMEE, A.

Steam boilers, effects produced by using muriate of ammonia as a means of preventing the incrustation of, v. 207, 209.

SMEE, W. A.

Electro-motive power. Cause of the failure, in an economic point of view, of electro-magnetic machines, xvi. 411.—How near a battery, acting over a considerable time, will do the work, due to the attraction going on, 416.—

SMITH.

Batteries effect what no mechanical force alone can, 417.

Smelting, *Vide* IRON; and IRON ORES.

SMITH, —.

Permanent way of the Bordeaux and Bayonne railway, xvi. 384.

Screw-moorings in the Tyne, vii. 148.

SMITH, A. [Election, iv. 291.]

SMITH, Captain G., R.N. [Election, i. (1840) 18.]

Screw propellers, vi. 294.

SMITH, Captain, M.E.

Lighthouses. "On the methods of illuminating lighthouses, and on a reciprocating light," i. (1837) 44.

SMITH, Colonel Sir F., R.E. [Election, i. (1841) 80.]

Bridges. His opinion of the Cowlin Brook bridge (Adie, A. J.), ii. (1842) 176.

SMITH, O. H.

Scaffolding, iii. 208, 209.

Stone, artificial, manufacture of, with a silica base, and warping and shrinking of terra-cotta ornaments in the process of baking, vii. 61.—Specific gravity, or weight, of different building-stones, 200.

SMITH, F. P. [Election, vii. 250.]

Screw propeller, iii. 73.—Best material for the screw shaft, iv. 171.—Results obtained by the screw in H.M.S. 'Rattler,' 172.—Relative merits of the screw propeller and paddle-wheels, 173, 175.—Combined use of the screw and sails in the 'Margaret' and 'Senator,' 178.—Praise due to him for his steady advocacy of the practicability of screw propulsion (Simpson, J.), xiii. 196.

SMITH, G.

Drainage of towns. "Description of the new sewer in the valley of the Cowgate, Edinburgh," i. (1841) 157.

SMITH, G. B. [Election, xvii. 128.]

SMITH, H. [Election, ix. 182.]

SMITH, J. (Deanston). [Memoir, x. 91.]

Air engine, Stirling's, iv. 358.

Canals, new system of lockage for, i. (1840) 53.

Drainage of land, iv. 202, 204.

Flax mill, Marshall's, at Leeds, ii. (1842)

SMITH.

- 143.—Construction of a mill on one floor, 143.—Description of his weaving shed, 143.
- Machine, Hunter's stone-boring, ii. (1842) 148.
- Railway cuttings, and drainage of embankments, iii. 151.
- Screw propellers, iii. 77.
- Sewage-manure, means for rendering it available for agricultural purposes, vii. 87.—Application of, on some meadow ground near the city of Edinburgh, on the Duke of Portland's estate, near Mansfield, and on a farm near Glasgow, 88.—Means of disposing of that of London, 89.
- SMITH, J. B.
Decimal coinage, &c. Adoption of ten shillings, as the unit of account, xiii. 328.—Expediency of adopting a decimal system for weights and measures, 329.
- SMITH, J. P. [Election, xi. 68; Telford medal, xiv. 105.]
Roads. "On macadamized roads for the streets of towns," xiii. 221.—Remarks, 229, 233.—Comparative cost of macadamizing and paving, as illustrated in the cases of Albert Place and Albert bridge, Manchester, 231.—Macadamized roads at Birmingham, 237.
- SMITH, O. H. [Election, iv. 291.]
- SMITH, R.
Coast at Dymchurch, xi. 212.
— and ELLIOTT, J.
Coasts, &c. Extract from their report on excavations at Lyme (O'Brian, Capt.), xi. 211.
- SMITH, S. W. [Election, iv. 186; resignation, xiii. 184.]
- SMITH, T.
Drainage of towns. Proceedings of the General Board of Health, xii. 69, 74.—Separation of surface-water from house-drainage, 70.—Relative merits of brick-sewers and pipe-drains, 71.—Materials for construction of sewers, 73.—Practical objections to system of pipe-drainage, 73.—Pipe-drainage at Tottenham, 75.—Principles of town-drainage, 75.

SMOKE.

- SMITH, T. M. [Telford medal, i. (1839) 10.—Election, i. (1840) 37.]
Bridges. "Account of the Pont-y-ta-Prydd, over the river Taaf, near New-bridge, in the county of Glamorgan," v. 474.
- Junction of the Atlantic and Pacific oceans. Communication from Commander Maclean, R.N., relative to the Isthmus of Panamá, ix. 81.
- Permanent way. Use of the hollow wrought-iron key, iv. 57.
- Tunnels. "An account of the repairs done to the Beechwood tunnel, upon the London and Birmingham railway, September, 1840," i. (1841) 142.
- SMITH, W. [Election, xvii. 410.]
Bells at the New Palace, Westminster, composition of the, xix. 14.
- Telegraph cables. Experiments to elucidate the causes of failure, xx. 87.—Ditto to ascertain the degree of heat which would affect the core of the Rangoon (Malta - Alexandria) cable, 88.
- Smith's (J.) fly vane governor, xvii. 367.
- SMOKE, PREVENTION OF.
Act of Parliament for, (Simpson, J.), xiii. 201.
"On the prevention of smoke in engine furnaces." By J. Simpson, Jun., xiii. 383.—Presence of black smoke indicates imperfect combustion, 383.—Early agitation of this question, 383.—Dr. Papin's plan for smoke consuming, 384.—Extracts from the reports of Committees of the House of Commons in 1819, 1820, 1843, and 1845, on the smoke nuisance, 384.—Smoke Nuisance Abatement Act, 1853, 385.—Clauses inserted in Bradford Improvement Act, 1802, and in Leeds Improvement Act, 1842, to compel the consumption of smoke, 385.—General desire in manufacturing districts to mitigate evil, 386.—Composition of coal, 386.—Smoke arises in various ways, and with different constituents, 386.—Extract from the report of the Committee on the Smoke Nuisance, at York, in 1852, 387.—Admission and diffusion in the

SMOKE.

furnace of atmospheric air necessary, 388. — Smoke-consuming machines, 388. — Use of anthracite, or superior Welsh steam-coal, 389. — Efficient stoking indispensable, 389. — Appendix. Description of some of the smoke-consuming apparatus at present in use, with remarks, 390. — Brunton's circular fire-grate, 390. — Juokes' endless chain fire-bars, 390. — Hazledine's oscillating transverse fire-bars, 391. — Hall's moveable fire-bars, 391. — C. W. Williams' apparatus, 391. — Apparatus at Oxford Twist Company's works, Manchester, 392. — Double-furnace boiler, 392. — Double furnaces, with combustion-chamber at the back-bridge, thence leading through tubes into the main-flue, 393. — T. Cubitt's system of passing air over a subsidiary fire, placed under the main furnace, 393. — Stoking generally very bad, 394. — Consumption of smoke by machinery defective, 394. — Double-furnace in use in Manchester, 395. — Multitubular boilers in general use in the manufacturing districts, 396. — Conditions essential to perfect combustion of smoke, 396.

“On the management of engine-furnaces, with a view to the prevention of the waste and nuisance from smoke.” By C. W. Williams, xiii. 397. — Chemistry of combustion, 397. — Most suitable place for introducing air into the furnace, 398. — Quantity of air that should be admitted, 401. — Whether skilful firemen are necessary, 401. — Use of self-acting valves, 402. — Mr. Houldsworth's pyrometer, for indicating the rise or fall of the temperature, within the working part of the flue, 402.

Discussion.—Arnott, Dr., 405. — Braithwaite, F., 405. — Eckstein, D., 411. — Fairbairn, W., 412. — Field, J., 410, 411. — Fraser, A., 406. — Hawkshaw, J., 407. — Jerrard, —, 411. — Marshall, J. G., 407. — Muir, G., 408. — Mushet, D., 411. — Poynter, A., 413. — Shears, W., 411. — Simpson, J., 415. — Simpson, J., Jun., 410. — Williams, C. W., 403,

SMYTH.

409. — Wilson, G. F., 406. — Wood, N., 418.

“On the means of avoiding visible smoke from boiler furnaces.” By W. Woodcock, xiv. 1. — Object of Smoke Nuisance Abatement Act, 1. — Nature of smoke, 2. — Formation of smoke or visible carbon, 3. — Means of preventing formation of smoke, 6. — Respective merits of hot and cold air in aiding combustion of smoke, 6. — Results of system employed at Messrs. Meux's brewery, 7. — Its advantages for war steamers, 7. — Description of Woodcock's furnace, 7. — Means of reducing temperature of engine and boiler holds of steam vessels, 13.

Discussion.—Armstrong, Sir W. G., 26. — Arnott, Dr., 21. — Brunel, I. K., 26. — Burney, J. B., 19. — Dye, C. H., 18. — Greaves, C., 16, 17. — Haywood, W., 17. — Jenkins, H. B., 15, 16. — Lowe, G., 18. — Mansfield, C. B., 19. — May, C., 29. — Rosser, S. E., 21. — Sewell, J., 15, 28. — Simpson, J., 17, 30. — Stevens, L., 24, 28. — Webster, T., 27. — Williams, C. W., 22. — Wilson, G. F., 23. — Woodcock, W., 14, 16, 17, 23, 29.

Smoke nuisance in the metropolis (Annual Report), xiv. 99. — Experiments upon the consumption of, xix. 567, *et seq.*

Vide also LOCOMOTIVE ENGINES.

SMYTH, W. W.

Geology. Phenomena of stratification and of cleavage of the primary rocks, xv. 60, 68. — Limestone quarry at Padstow, in Cornwall, 64. — Slate quarries of Ffestiniog, 64.

Metals. Dressing of tin and copper ores, and deficiencies in the processes, xvii. 216. — Herr Rittinger's apparatus, in use in the Hartz mines, for conveying the stuff from the stamps to where the materials are finally concentrated, 217. — Relative merits of the stamping-machine and crushing-rollers, 218. — Processes for removing wolfram from tin, particularly that in use in the mines of the Duke of Cornwall, and that of Mr. Oxland, 219.

SNELL.

Mines. Difference in the systems of mining and of ventilation adopted in the North of England and in the South Wales coal-field, viii. 129.—Various aids to ventilation, including Mr. W. P. Struvé's and other mechanical ventilators, the use of fans, and the steam-jet, 129.—Methods of working coal, 130.—Current of air passing through a mine, 131.—Principal causes leading to the explosion at the Eaglesbush colliery, 131.—Necessity for improving the moral and intellectual condition of the colliers, and particularly of the underground agents, 133.—Advantages that would result from the improvements of well-regulated collieries being carried to works at present ill-managed, 134.

SNELL, G. [Election, ii. (1843) 134; Telford medal and Council premium, vi. 2; resignation, x. 72.]

Arches, modes of finding the line of resistance in, v. 178, 181.

— "On the stability of arches, with practical methods for determining, according to the pressures to which they will be subjected, the best form of section, or variable depth of voussoir, for any given intrados or extrados," v. 439.—Remarks, 464.—Failure of an arch, under the theoretical conditions of the materials being infinitely strong, to resist compression, 464.—Practical application of theoretical investigations, 465.—Strength of building materials, 466.—Determination of the centres of gravity of surfaces, required in the application of the problems, in the preceding articles, 466.—Method of avoiding the repetition of the calculation for every separate portion of the arch under consideration, 467.—Application of the preceding principles to an examination into the conditions of stability of the arch of the Pont-y-tu-Frydd, 468.

SNOW, B. [Election, iii. 173.]

Society of Civil Engineers, of Paris, letter from, inviting members of Institution to attend their meetings during the Universal Exhibition in 1855, xiv. 251.

SPARKES.

SOPWITH, T. [Telford medal, ii. (1842) 7; Member of Council, v. 142; vi. 46; vii. 56.]

Arches, and models used in illustrating Mr. W. H. Barlow's paper on, v. 173.

Civil engineers. Importance of the connection between civil engineers and geologists, ii. (1842) 141.

Coal-field of the Forest of Dean, i. (1840) 49.

Ferries. "Account of the steam-ferry over the river Nile, at Kaffre Azmayat," xvii. 53.—Remarks, 63.

Geology. Sections of railway cuttings, i. (1841) 61.—Models for familiarly explaining geological phenomena, 62.

— "On the construction and use of geological models in connection with civil engineering," i. (1841) 163.

Landslip in Ashley cutting, iii. 134.

Mines, temperature of, ii. (1843) 142.

Models generally superior to plans for illustrative purposes, v. 173.

Railway cuttings, &c., iii. 152.

SORENSEN, B. [Election, ii. (1843) 183.]

Soundings, want of a good instrument for deep-sea, xi. 22.

South Eastern railway, permanent way of the, (Pope, J.), ii. (1842) 72.

SOUTH, Sir J.

Huddart's equatorial instrument, ii. (1842) 57.

SOUTH, T. G. [Election, xv. 246.]

Sovereigns, machine for weighing, ii. (1843) 121.

SPURRY, W. [Election, viii. 261.]

Iron ore. "Some account of the recently discovered deposits of iron ore at the foot of the Himalayas, in Kumaon, Northern India," xvi. 82.

Metals. Specimens of coal, iron, copper, galena, &c., discovered in South-Eastern Africa, xvi. 84.

Permanent way, system of, to be adopted upon the Indian railways, xvi. 285.

Spain, railway system in, xix. 148.

SPARKES, G.

Decimal coinage, &c. Radical defect of decimal system, that the number of figures required to indicate fractional sums will be increased, xiii. 344.

[SPENCE.

SPENCE, T. B.

Docks, Limekiln, and entrances to wet docks, vii. 177.

SPENCE, W. [Election, i. (1840) 68.]

SPENCER, —.

Boilers, tubular, xv. 303.—Relative influence of internal and external firing in producing explosions, 304.

SPENCER, J. F.

Marine engines. Surface condensation, and application of the system in the iron screw steam-ship 'Alar,' xviii. 293. Screw propeller, Griffiths', xiv. 409.

Ships and steam vessels. Ballasting ships, xiv. 352.—Proportion of power to tonnage in steam ships, 400.—Usual average of steam-ship performances, xviii. 292.

Spencer's corrugated-iron longitudinal sleepers, xvi. 257.

SPEKING, R. A. [Election, xix. 263.]

SPICE, R. P. [Election, xiv. 523.]

SPIERS, J. [Election, xx. 292.]

SPILLER, J. [Election, i. (1841) 87.]

Ericsson's caloric engine. Power of the engines of the caloric ship 'Ericsson,' xii. 347.—'Regenerator' in ditto, 348.

Fluids, relation between the velocity and the resistance to bodies moving through, v. 279.

Spithead Forts. Report of the Defence Commissioners, and letters from General Burgoyne and Sir W. Armstrong, relative to the, xx. 555.—Reply of Capt. C. P. Coles, R.N., to, 581.

Springs for indicators, ii. (1842) 106.

Springs for watches, vi. 224, *et seq.*

Springs, volute, on the application of, to the safety-valves of locomotive boilers (Baillie, J.), xv. 28.—Their application, as bearing, buffer, and traction springs, to locomotive engines and tenders, waggon, trucks, and carriages; and as auxiliary springs for common road carts and waggons, 37.—Adaptation of, to hydraulic safety-valves, for the Amsterdam water-works, 42.—Ditto, to engines on Hungarian and Austrian lines, 43.

SQUIRE, Honourable E. G.

Junction of the Atlantic and Pacific

STEAM.

oceans. Letter containing some remarks on the remains of an extinct volcano near the city of Santiago de Nicaragua, ix. 81.

Staff, improved levelling, i. (1838) 47.

—, description of an improved levelling, and a modification of the common level (Stevenson, T.), i. (1841) 130.

Stand-pipe, East London water-works, iii. 214.

STANHOPE, Lord.

Roofs, his fire-proof composition for, (Hogg, P.); ii. (1843) 94.—Proportion of materials, mode of preparation, and of application, 94.

STANLEY, W., Jun. [Election, xix. 130.]

STANFIELD, J. [Election, i. (1838) 15.]

STANTON, J. H. [Election, xx. 106.]

STATHAM, T. H. [Election, iv. 372; memoir, xvi. 142.]

Electric telegraph. Insulated wire coated with gutta-percha, and covered with lead, xi. 378.

Permanent way of the Dublin and Drogheda railway, v. 241.—Permanent way of railways, viii. 271.

Stationary engine system of traction, by ropes wound round drums, or cylinders, as adopted in the collieries of the north, v. 78.—Ditto, as applied on the Blackwall railway, 79.

STATTER, T. [Election, xvii. 483.]

STAVELL, J. [Resignation, viii. 10.]

STEAM.

"A steam expansion table." By G. Edwards, i. (1837) 24; (1838) 42.

"On the application of steam as a moving power, considered especially with reference to the reported duties of the Cornish and other engines." By G. H. Palmer, i. (1837) 38.

"On the results obtained by Mr. G. H. Palmer, respecting the maximum duty of a given quantity of atmospheric steam." By T. Webster, i. (1837) 41.

"On the expansive action of steam in Cornish engines." By W. J. Henwood, i. (1838) 13.

"On the economy of working expansively in crank engines." By J. Watt, i. (1839) 44.

STEAM.

- Discussion.—Enys, J. S., 45.
- "A theoretical calculation of the fuel saved by working steam expansively." By J. W. Lubbock, i. (1840) 3.
- "On the action of steam as a moving power in the Cornish single pumping engine." By J. Parke, i. (1840) 75.
- Data employed, 76.—Methods of applying steam, 76.—Absolute resistance to the steam, 76.—Force of the steam at the end of the working stroke, 76.—The expansive and unexpansive action of steam separated, 76.—The deficiency of power, 77.—The percussive action of steam, 77.—The conditions of a Cornish engine, and theory of the action of the steam, 77.—Action of the cushion of steam, 78.
- Discussion.—Field, J., 80.—Parkes, J., 80.—Rendel, J. M., 79.—Seaward, S., 78.—Wicksteed, T., 78, 79.
- "On the percussive action of steam and other æriform fluids." By J. Parke, i. (1841) 149.—Experiments with the indicator, 149.—Ditto mercurial column, 149.—Mr. Perkins' steam generator, 149.—Different circumstances of the single pumping and crank engines, 150.—The springing of cylinder covers, 150.
- Discussion.—Homersham, S. C., 151.—Lowe, G., 150.—Parkes, J., 152.—Seaward, S., 152.
- Work done by, as the moving power upon the piston of an engine defined (Moseley, Prof.), ii. (1842) 114.—Cut off at a portion of the stroke, 114.—High pressure, contributed to accelerate the change of cast iron into plumbago (Farey, J.), 153.—Assumption that steam is a permanently elastic fluid (Stephenson, R.), v. 429.
- "On the expansive action of steam." By J. M. Heppel, vi. 316.—Dynamical effect produced by using, 316.—Formulæ for ascertaining the relation between the pressures and relative volumes, 318.—Causes tending to modify the theoretical results, 322.—Formula for the flow of æriform fluids through pipes, 329.—Action of the

STEAM.

- cushion, 329.—Experiment for ascertaining the forces in action during the working of a pumping engine, 331.—Appendix, table of relative volumes and dynamical effects of steam, 334.—Discussion.—Bidder, G. P., 339, 341.—Brande, Prof., 337.—Froude, W., 337.—Glynn, J., 337.—Gravatt, W., 339.—Hawkins, J. I., 338.—Hocking, S., 340, 342.
- "On the law of the expansion of steam." By T. Tate, vi. 343.—Work of steam considered in relation to the formula $V = f(P)$, 346.—Principle of the conservation of the work of steam, 347.—Work of steam considered in relation to the formula, $V = a + b P^2$, 349.
- "Observations on salt water, and its application to the generation of steam." By J. B. Huntington, xii. 506.—Short history concerning salt water, 506.—Contrivances for preventing injurious action and incrustation of salt water in marine-boilers, 507.—Ditto for determining the quantity of salt the water of the boiler contains, 509.—Mandalay and Field's experiments to ascertain the state of the brine, 511.—Dr. Lardner's ditto, 511.—Seaward's salt gauge, 512.—Method of preventing incrustation, 512.—Scott Russell's instrument for ascertaining the density of the water in the boiler, 513.—Analyses of seawaters, 514.—Results arrived at by the experiments as to saltness of water, and the boiling-point of solutions, &c., 516.
- Discussion.—Huntington, J. B., 518.—Ritterbandt, Dr., 518.
- Results of using, expansively, in marine engines, xvi. 338, *et seq.*
- "On combined steam." By the Hon. J. Wethered (U. S. America), xix. 462.—Application of ordinary and superheated steam, mixed, 463.—Objections to the use of steam simply dried, or superheated, 464.—Practical illustration of the efficiency of mixed steam in the 'Avon', 464.—Experiments conducted by order of the Lords of the Admiralty, 465.—Examples of the

STEAM.

application of combined steam, with the results obtained, 465.—Advantages of this system, 466.

Discussion.—Beardmore, W., 474.—Bidder, G. P., 487.—Cowper, E. A., 483.—Dinnen, J., 476.—Dorman, W. H., 484.—Fletcher, L. E., 480.—Greaves, C., 482.—Hobbs, A. C., 483.—Howard, T., 474, 476.—Humphrys, E., 470, 473.—James, J., 482.—Longridge, J. A., 468.—May, C., 476.—Parson, G. J., 473.—Patridge, D., 471, 476.—Rennie, G., 478.—Siemens, C. W., 479.—Topham, J., 472.—Wethered, Hon. J., 468, 485.

Vide also COAL; FUEL; INDICATORS; LOCOMOTIVE BOILERS; LOCOMOTIVE ENGINES; MARINE ENGINES; STEAM BOILERS; and STEAM ENGINES.

Steam and sailing colliers, on the comparative cost of transit by, and on the different modes of ballasting (Allen, E. E.), xiv. 318.—*Vide* COLLIERIES.

Steam-boat passengers on the river Thames, accommodation for embarking and disembarking, xv. 216.

STEAM BOILERS.

Construction of. "On the construction and proper proportions of boilers for the generation of steam." By A. Murray, iii. 331.—Combustion of coal 331.—Air supplied, 331.—Forms of furnace, 331.—Forms of fire bars, 331, 333, 336.—Supply of air to mingle with the inflammable gases, 332.—Composition of the gases evolved during the combustion of the fuel, 332.—Williams' system of furnace, 333.—Mode of firing, 334.—Parkes' experiments on boilers, 334.—Cornish boilers, 335.—Draught in flues, 335.—Relative proportions of parts of boilers, 336.—Ash-pit, 336.—Dead-plate, 336.—Fire-bars, 336.—Area of flues, 337, 339.—Temperature in the furnace, 337.—Angles in flues, 338.—Amount of heating surface, 340.—Tubular boilers, 340.—Dimensions of chimney, 341.—Temperature in chimney, 341.—Steam reservoir, 342.

Construction of. "On the results of the

STEAM BOILERS.

use of tubular boilers, or of flue-boilers of inadequate surface, or imperfect absorption of heat." By Admiral the Earl of Dundonald, xi. 388.—Trials of evaporative power of boilers having vertical water-tubes, 389.

"On certain points in the construction of marine boilers." By J. S. Russell, xi. 390.—Practical results arrived at, 391.

"Description of a diaphragm steam generator." By T. H. Boutigny (d'Evreux), xi. 392.—Non-liability to explosion, 396.

Discussion.—Armstrong, Sir W. G., 399.—Bidder, G. P., 406.—Boutigny, T. H., 398, 404.—Brunel, I. K., 402.—Faraday, Dr., 398, 403.—Glynn, J., 398.—Gordon, A., 399.—Hawksley, T., 405.—Homersham, S. O., 407.—Hunt, R., 404.—May, C., 402.—Murray, A., 397, 399, 403.—Russell, J. S., 403.—Stephenson, R., 400.

Duration of the boilers of the 'Garry Owen' iron steamer, ii. (1843) 178, *et seq.*

Evaporation from. "On the evaporation of water from steam boilers." By J. Parkes, i. (1838) 17.

Explosions of, i. (1838) 41, 42, 43.

—"Description of an apparatus for preventing the explosion of steam boilers." By R. M'Ewen, i. (1840) 55.

—"On the circumstances under which the explosions of steam boilers generally occur, and on the means of preventing them." By Dr. Schafhaeuti, i. (1841) 103.

Discussion.—Donkin, B., 114.—Field, J., 114.—Parkes, J., 106.—Seaward, S., 113, 114.—Walker, J., 114.

Explosions of. "Account of the explosion of a steam boiler at the Pen-y-darran iron-works, South Wales." By A. Stephens, ii. (1842) 145.

—, probably due to 'fatigue' at the angles (Sewell, J.), xiii. 471.

—"On the causes of the explosions of steam boilers." By W. K. Hall (U. S. America), xv. 281.—Explosion at the Hartford steel works, Sheffield, on the

STEAM BOILERS.

18th of August, 1855, 282.—Explosions not due to electricity, nor to formation of gas, 282.—Explosion at Consett iron-works, Gateshead, 282.—Effect of applying heat to steam, 282.—Explosion at Chiswick, July 16, 1855, 283.—Effect of bringing water into intimate contact with superheated steam, 283.—Explosion at the Tower Mills, Sheffield, August 11, 1855, 283.—Explosions at the Kebblesworth colliery, on September 19, and at the Walker iron-works, at Newcastle, on October 8, 1855, 283.—Fusible metal plug enjoined by law in France rendered inoperative by use, 284.—Contrivances hitherto adopted for the purpose of providing against explosions, 284.—Proposed water blow-off valve, 284.

Discussion.—Fletcher, L. E., 304.—Gregory, C. H., 301.—Hall, R. B., 292.—Hall, W. K., 286, 305.—Hawshaw, J., 299.—Hobbs, A. C., 301.—Humphrys, E., 299, 300.—Longridge, J. A., 294.—Pearsall, T. J., 297, 305.—Pole, W., 297.—Spencer, —, 303.—Stephenson, R., 307.—Webster, T., 305.—Woodcock, W., 286, 302.—Woods, E., 293.

Height of water in, method of regulating the, xvi. 308.

Incrustation of, v. 182, *et seq.*

Marine, conditions most and least favourable to corrosion in, (Mallet, R.), ii. (1843) 176.—Temperature of water in, 176.

Piston-meter for measuring hot as well as cold water for, (Jopling, T. T.), xvi. 50.

Plates of, injury caused to the, by the vibratory waves of expansion and contraction (Sewall, J.), xix. 16.

Priming in, viii. 176, *et seq.*

Sight-tubes for, (Williams, C. W.), ii. (1842) 154.

Vide also COAL; FUEL; INDICATORS; LOCOMOTIVE BOILERS; LOCOMOTIVE ENGINES; MARINE ENGINES; STEAM; and STEAM ENGINES.

Steam coaches, notice of several inventions and trials to enable, to travel on turnpike roads, v. 77.

STEAM ENGINES.

Steam cushion, ii. (1842) 120.

Steam drainage first introduced by the late Mr. Rennie at Bottisham fen, near Ely, v. 48.

Steam-engine indicator, Hulford's, xii. 431.

STEAM ENGINES.

Air-pump buckets of, a perfect galvanic apparatus (Taylor, J.), ii. (1842) 154.

Beam and direct action. "An investigation of the comparative loss by friction in beam and direct-action steam engines." By W. Pole, ii. (1843) 69.

Discussion.—Davison, R., 79.—Farey, J., 78.—Field, J., 70.—Gravatt, W., 73.—Miller, J., 71.—Murray, J., 71, 78.—Paaley, Lieut.-Gen. Sir C. W., 78.—Pole, W., 73.—Rennie, G., 79.—Taylor, J., 70.—Vignoles, C., 72, 77.

Butterley iron-works, steam engines for blowing the furnaces at, (Kreeft, S. C.), ii. (1843) 121.

Construction of. Observations on defective workmanship in steam engines (Mills, G.), iv. 296; (Field, J.), 296; (Farey, J.), 346.

Cornish. "On the Cornish engines." By T. Wicksteed, i. (1838) 2.

Discussion.—Lowe, G., 3.—Parkes, J., 9.—Walker, J., 12.—Wicksteed, T., 6.

Cornish. "Observations on the efficiency or gross power of steam exerted on the piston, in relation to the reported duty of steam engines in Cornwall, at different periods." By J. S. Enys, i. (1840) 1.

Duty of, i. (1837) 39; (1840) 22, *et seq.*

Effective power of. "On steam engines, principally with reference to their consumption of steam and fuel." By J. Parkes, i. (1840) 6.—Effective power of, 7.—Measures of effect, 7.—Expenditure of power, 8.—Proportion of boilers to engines, 8.—Relative economy of engines, 8.—Standard of comparison, 8.—Constituent heat of steam, 9.—The locomotive engine considered, 9.—Of momentum as a measure of effect, 12.—The blast, 13.—Fixed and locomotive non-condensing engines, 14.

Discussion.—Enys, J. S., 15, 17.—Field,

STEAM ENGINES.

- J., 16.—Parkes, J., 16.—Wicksteed, T., 15.
- Elastic metallic piston, W. and C. Mather's, vii. 289.
- Evaporative power of. "On steam boilers and steam engines." By J. Parkes, i. (1839) 54.—The evaporative power of different kinds considered, 54.
- Discussion.—Parkes, J., 58.
- Glasgow water-works. Reasons for not using steam engines in 1780 for supplying Glasgow with water (Mackain, D.), ii. (1843) 134.—First erection of ditto at the Glasgow water-works, 135.
- High-pressure, worked expansively. "On the pressure and density of steam, with a proposed new formula for the relation between them; applicable particularly to engines working with high-pressure steam expansively." By W. Pole, ii. (1843) 209.—Formulae for expressing the approximate relation between pressure and temperature, 210.—Laws of Boyle and Gay Lussac used for deducing the density, the pressure and temperature being known, 210.—Simple rule desirable for this, 210.—Formulae of Navier and Pambour, 210.—Formula for a case not provided for by others, 210.—Case of Woolf's double-cylinder engines, 210.—Advantages of new formula, 211.
- "On the pressure and density of steam, with a proposed new formula for the relation between them; applicable particularly to engines working with high-pressure steam expansively." By W. Pole, vi. 350.—M. Navier's formula, 352.—M. de Pambour's modifications of ditto, 352.—Tables of comparison of the results of the four formulae, and deviation from truth of each, 354.—Advantages of proposed formula, 354.
- History of the progressive improvements in, (Rennie, Sir J.), v. 20.
- Horse-power of. "On the nominal horse-power of steam engines." By Com. L. G. Heath, R.N., x. 306.—Unfitness of the constant factor 7 to represent

STEAM ENGINES.

- the mean effective pressure, 306.—Admiralty formula for determining horse-power, 307.—Table of length of stroke and number of revolutions per minute, 307.—Fallacies by taking the revolutions from the Admiralty table, 307.—Nominal horse-power does not represent relative size of engines, 307.—General definition recommended for determining the size and first cost, as well as the expenditure, daily cost, and comparative power of engines, 308.—Engines should be designated by the cubic contents of their steam cylinders, jointly with their nominal consumption of a standard description of fuel, 309.
- Discussion.—Bethell, J., 313, 315.—Cowper, C., 310, 315.—Crampton, T. R., 313.—Cubitt, Sir W., 316.—Enys, J. S., 313.—Farey, J., 315.—Field, J., 312, 315.—Hawthaw, J., 310, 314.—Henderson, A., 314.—Heppel, J. M., 313.—Homersham, S. C., 311.—Humphrys, E., 314, 315.—May, C., 315.—Matthew, J., 311.—Moorson, Capt. W. S., 313.—Pellatt, A., 311.—Radford, W., 311.—Rennie, Sir J., 310.—Stephenson, R., 309, 310, 311.—Thomson, D., 312, 314.—Wordsworth, C., 313.
- Huel Towan. "On the experiments and results of Mr. W. J. Henwood, as to the power of the Huel Towan engine." By G. Woods, i. (1840) 30.
- Long and short stroke engines. "Remarks on the comparative advantages of long and short connecting rods, and long and short stroke engines." By J. Seaward, i. (1841) 53.—Of H.M. steam frigate 'Gorgon' described, 53.—Inquiry into the comparative advantages of long and short connecting rods, 54.—Ditto relative amount of friction in the two classes, 55.
- Metallic packing of, liable to destruction from galvanic action (Farey, J.) ii. (1842) 153; (Taylor, P.), 153.
- Newcomen's principle, first used for raising coal and pumping water in the Northern coal districts (Atkinson, R. T.), ii. (1842) 171.
- Single acting, and crank engine, compe-

STEAM ENGINES.

- rative merits of the, for raising water, i. (1837) 81.
- Stamping. "On the stamping engines in Cornwall." By J. S. Enys, i. (1840) 83.—Reported duty of, 83.
- Stationary. "On the stationary engines at the new tunnel on the Liverpool and Manchester railway." By J. Grantham, i. (1841) 146.—Dimensions of, 146.—Inclined plane worked by, 147.—Original boiler and steam pipes, 147.—New boilers, 148.
- Discussion.—Fairbairn, W., 148.
- Stationary, at Blackwall railway (Robertson, A. J.), v. 148, *et seq.*
- , and marine. "The advantages of working stationary and marine engines with high-pressure steam, expansively and at great velocities, and of the compensating or double crank system." By J. G. Bodmer, iv. 372.—On the advantages of the variable expansion gear, 373.—Conditions under which high-pressure steam and ditto can be best applied, 373.—Bodmer's compensating, or double crank system, and its advantages, 374.—Extent to which the expansive action of steam may be carried, 375.—Description of a 60 H.P. compensating engine, erected for Messrs. Horridge and Holmes, of Bolton-le-Moors, 375.—Comparison between two engines, the one of slow and the other of quick velocity of the crank shaft, 377.—Description of examples and diagrams, 377.—On the irregularities of motion in steam engines, 378.—Application of the expansion principle to condensing engines considered, 379.—Comparative statements relative to the velocity of the crank shaft of single crank engines, 379.—Means of saving fuel in engines, 380.—Description of the tables appended to communication, 382.—Calculation relative to the first of the series of examples contained in Table I., 383.—Calculations relating to the compensating engine, Example 1, 385.—Ditto, Example 2, 386.—Ditto, the single crank engine, Example 3, 388.—Ditto, Example 4, 389.—

STEAM NAVIGATION.

- Details of a pair of 300 H.P. compensating marine engines, 391.—Ditto of a 200 H.P. compensating stationary engine, 391.—Table of results obtained from various calculations of a marine engine of 600 H.P., 392.—Table of data and results relating to a marine engine of 600 H.P. constructed according to the usual proportions, and to a compensating engine of the same effective power, 393.—Description of a pair of 300 H.P. marine engines constructed on Bodmer's compensating principle, 394.—Ditto of a 200 H.P. stationary engine on ditto, furnished with the variable expansion gear, 396.
- Vide also* COAL; COMBINED VAPOUR ENGINE; FUEL; INDICATORS; LOCOMOTIVE BOILERS; LOCOMOTIVE ENGINES; MARINE ENGINES; STEAM; STEAM BOILERS, and STEAM GAUGE.
- Steam expansion table (Edwards, G.), i. (1838) 42.
- Steam-ferry over the river Nile, at Kaffre Azayyat, account of the, (Sopwith, T.), xvii. 53.
- STEAM GAUGE.
- "On the thermometric steam gauge." By A. J. Adie, i. (1838) 15.
- Steam-hammer, single, or double-acting, xvi. 307.
- Steam-jacket, duty of a Cornish engine with and without a, i. (1838) 7.
- Steam-jet, the, considered as a means of ventilation for mines, x. 35, 49, 53.—Experiments by Mr. N. Wood, Mr. G. Elliot, and Mr. H. H. Vivian, 36.—Application of the steam-jet to the Seaton Delaval colliery, 51.—Trials of the efficacy of the steam-jet at the Tyr Canal and Margam collieries, near Swansea, 56.
- STEAM NAVIGATION.
- "Upon the application and use of auxiliary steam power, for the purpose of shortening the time occupied by sailing ships upon distant voyages." By S. Seaward, i. (1841) 63.—Limited duration of steam voyages, 64.—Relation between the power and velocity, 64.—Ditto of fuel and size of engines, 64.—

STEAM NAVIGATION.

- Proportion of power to tonnage considered, 65.—Notice of pamphlet "on the possibility of successfully employing steam power in navigating ships between this country and the East Indies, by the Cape of Good Hope," 65.—Application of auxiliary steam power, 66.—Ditto to the 'Vernon' East Indiaman, 66.—Table of velocities of steamships, 67.
- Discussion.—Cubitt, Sir W., 71.—Field, J., 70, 71.—Mills, G., 70.—Seaward, S., 68, 72.—Parkes, J., 71.—Vignoles, C., 70.—Walker, J., 70.
- "Supplementary account of the use of auxiliary steam power on board the 'Earl of Hardwicke' and the 'Vernon' Indiamen." By S. Seaward, i. (1841) 129.
- History of the progressive improvements in, (Rennie, Sir J.), v. 81.
- "On ocean steam navigation." By A. Henderson, vi. 484.—Comparative advantages of paddle-wheels and screw-propellers, 486.
- Discussion.—Farey, J., 489.
- Application of the steam engine to navigation (Field, J.), vii. 35.—Progress of the marine engine and steam navigation, 38.—High speed attained by the introduction of the tubular boiler, 40.—Introduction of the screw propeller, 42.—Progress of steam navigation (Cubitt, Sir W.), ix. 139; (Rendel, J. M.), xi. 158.
- "On the speed and other properties of ocean steamers, and on the measurement of ships for tonnage." By A. Henderson, xiii. 1.—Speed of mail-packets for six years between England and Bombay, and for three years between Suez, Calcutta, and China, 2.—Relative speed of different vessels, 2.—Peninsular and Oriental Company undertake a contract to maintain an average speed of 10 knots per hour, 3.—'Great Western,' unaided by Government, attained a speed of 8.82 knots per hour on her first voyage to America, 4.—'India,' between Calcutta and Suez, in 1842, 4.—Inaccuracy of term,

STEAM NAVIGATION.

- 'nominal horse power,' 5.—Estimate of the relative resistance of vessels, 5.—Relative proportions and form of vessels, as derived from the ratios of their length and depth to their breadth, 5.—Particulars of the 'Orinoco,' West India mail packet, 6.—Limits of length and power for steam-ships, 6.—Dimensions of Noah's Ark, and several ancient vessels, 7.—'Baron of Renfrew,' 8.—'India,' 8.—Proposed 'Comprehensive,' for the East India Steam Company, 9.—Comparison of the tonnage, dimensions and proportions of steam vessels, 9.—Advantage of curve of areas of resistance and of tonnage displacement, 10.—Ratio of height of deck, or depth of hold, to the breadth, an important element in the computation of the tonnage, 11.—Basis for the measurement of ships recommended by the Tonnage Committee of 1849, 11.—Particulars of the 'Orinoco' and 'Solent,' West India mail packets, and 'Asia' and 'Arabia' of the Cunard line, 12.—Of the 'Arctic,' 'Susquehanna,' and 'Golden Age,' of the Collins line, 13.—Of the 'Great Britain,' 13.—Of the 'Himalaya' and 'Bengal,' Peninsular and Oriental Company's service, 14.—Of the 'Victoria,' for the Australian trade, 14.—Of the clipper ship 'Great Republic,' 15.—Of the 'Great Eastern,' 15.—On the measurement of ships for tonnage, 16.—Reports of Commissions for considering, in 1821 and 1835, Act of 1836, and amended Act of 1844-45, 17.—Report of Commission in 1849, 17.—Bill of 1850, 17.—Mode of internal measurement proposed by Mr. G. Moorsom, 18.—Diagrams and curves of areas can be usefully employed in the measurement of ships, 18.—Form of certificate of survey, containing directions, 19.—Specification of vessel to be appended to the certificate of survey, 20.—Principle recommended, difference between external and internal measurements, 22.—Particulars to be recorded on the register, 25.—Fishing and life-

STEAM NAVIGATION.

- boats, 26.—Fisherman's life-boat, 28.
 —Appendix, comprising directions for external measurement, and for forming the curves of areas; rules for computing the internal bulk, for internal measurements, for ascertaining the registered tonnage, and directions for forming the scale of displacement, 29.
 Discussion.—Atherton, C., 40, 53, 62.—Bidder, G. P., 46, 55, 63.—Fitzroy, Admiral, 31, 62.—Gordon, A., 62.—Henderson, A., 31, 33, 54, 57, 61, 63.—Hoseason, Capt., 45, 54.—Manby, C., 55.—Rendel, J. M., 32, 60.—Rennie, G., 56.—Roberts, R., 39.—Russell, J. S., 50, 54, 61.—Slate, A., 31.—Vignoles, C., 62.
 Mr. F. P. Smith's steady advocacy of the practicability of screw propulsion (Simpson, J.), xiii. 196.—Facilities for coaling large ocean steam ships on long voyages, 197.
 "On the application of the screw propeller to the larger class of sailing vessels." By R. A. Robinson, xiv. 375.—Reasons for withdrawal of larger class of screw ships, placed upon the long-sea routes to India and Australia, 375.—Means of disconnecting or lifting the screw out of water, 379.—Analysis of voyages of four clipper sailing-ships to Australia and India, 382.—American clipper ships navigated by Lieut. Maury's wind and current charts, 383.—Proposed employment of iron sailing clipper ships, 383.—Comparison between wooden sailing clipper ship without steam-power, and iron sailing clipper ship with steam-power, 385.—Application of auxiliary steam-power to sailing ships, 386.—Proposed alterations in construction of iron ships, 387.—Appendix, table of auxiliary screw ships, 389.
 Discussion.—Allen, E. E., 405.—Atherton, C., 394, 399.—Bazalgette, J. W., 406.—Bidder, G. P., 390, 416.—Claxton, Capt., 396.—Crampton, T. R., 396.—Eldridge, Capt. A., 391, 406.—Halsted, Capt., 400.—Hays, Capt., 395.—Henderson, A., 408.—Hoseason, Capt.,

STEAM-POWER.

- 390, 406.—Manby, C., 415.—Martin, Capt., 408.—Maudalay, H., 393.—Robinson, R. A., 398, 414.—Russell, J. S., 410.—Saunders, T., 410.—Simpson, J., 396, 406.—Spencer, J. F., 409.—Wimahurst, H., 394.
 "On high speed steam navigation; and on the relative efficiency of the screw propeller and paddle wheels." By R. Armstrong, xvi. 327.—Desirable to separate the performances of the machinery from the question of the form of the vessel, 327.—Propelling-power as the square, and not as the cube, of the velocity, 327.—Details of the trials of the French war-steamer 'Charlemagne,' 328.—Conclusions, 329.—Length the most important element for high speed, 329.—Comparison of the trials of the 'Himalaya' screw-steamer, with the 'Atrato,' paddle-wheel steamer, 330.
 Discussion.—Airy, Prof., 343.—Armstrong, R., 331, 365.—Atherton, C., 334.—Bidder, G. P., 342, 368.—Bramwell, F. J., 361.—Dinnen, J., 333.—Griffiths, R., 344.—Hawkeley, T., 355, 360.—Henderson, A., 363.—Humphrys, E., 338, 361.—McConnell, J. E., 345.—Phipps, G. H., 337, 360.—Rennie, G., 341.—Russell, J. S., 331, 352.—Samuda, J. D'A., 340.—Wimahurst, H., 337.
 Progress of, (Annual Report) xviii., 170.—Mr. Brunel's exertions in accelerating the progress of ocean steam navigation, (Bidder, G. P.), xix. 214.
Vide also COLLIERIES; COMBINED VAPOUR ENGINE; MARINE ENGINES; and SHIPS AND STEAM VESSELS.
 Steam Navigation Company, Peninsular and Oriental; returns of accidents to screw and paddle shafts in their fleet, xviii. 344.
 Steam-power. Supplementary account of the application and use of auxiliary steam-power, on board the 'Earl of Hardwicke' and 'Vernon' Indiamen, (Seaward, S.), i. (1841) 129.
 —to propulsion, the application of, and modern improvements in gunnery, changes which, have produced, xx. 396.

STEAM RAMS.

Steam rams, practicability and advisability of constructing, considered, xx. 401, *et seq.*

Steam towing on canals, xvii. 396, *et seq.*

Steel, *Vide* IRON and STEEL; and METALS.

STEEL, T. [Election, i. (1840) 83.]

STEEL, T. D. [Resignation, xv. 85.]

STEEL, T. E. [Memoir, viii. 16.]

Steering, description of a new mode of, as applied to boats of light draught of water, navigating shallow and rapid rivers (Henderson, Capt.), i. (1841), 80.

STEIN, A. [Election, xvii. 410.]

STEPHENS, A. [Walker premium, ii. (1843) 7.]

Steam-boilers, explosion of. "Account of the explosion of a steam-boiler at the Penydarran ironworks, South Wales," ii. (1842) 145.

STEPHENSON, G.

Career of, noticed by Mr. Field, President, in his address to the annual general meeting, viii. 29.

Locomotive engines. Improvements in the locomotive engine (Rennie, Sir J.), v. 71.—Description of his engine the 'Rocket,' 72.

STEPHENSON, G. B. [Election, xii. 601; Member of Council, xix. 132; xx. 108.]

Drainage of land. Depth of under-drainage, xx. 230.

Permanent way. Weight of rails suitable for heavy loads at express speeds, xx. 286.

STEPHENSON, H. P. [Election, xii. 520.]

STEPHENSON, R., M.P. [Member of Council, i. (1837) 15; (1838) 20; (1839) 27; iv. 62; v. 142; vi. 46; Vice President, vii. 56; viii. 44; ix. 91; x. 60; xi. 84; xii. 112; xiii. 123; xiv. 97; President, xv. 76; xvi. 88; memoir, xix. 176.]

Address, on taking the chair for the first time after his election as President, xv. 123. *Vide* also RAILWAYS, British.

Air engine, Stirling's, iv. 358.

Arches, v. 174.—Analogy between the arch and a trussed girder, 176.—Line of pressure in arches, 177.—Investigations into the stability of arches, 464.—Experiments upon elliptical cast-iron

STEPHENSON.

arches, and as to employment of cast or wrought iron, in the arch form, for bridge purposes, xviii. 360.

Beams. Combination of cast-iron beams and wrought-iron tie-rods, vi. 219.—Neutral axis of a beam, xiv. 469.—Presumed economy in weight of iron from using lattice-beam, 474.—Loss of material at intersections of lattices, 479.—Vertical rib of beams, xv. 193.

Bequest of, xix. 164.

Blasting under water. Firing of gunpowder under water by means of the galvanic battery, xv. 340.

Bridges. Railway bridge over the Dee, at Chester, vi. 220.—Relative merits of plate, or trellis sides for railway girder-bridges, xiv. 468.—Adaptation of suspension bridges to railway purposes, 486.—Calculations of the tubes for the Conway and Britannia bridges, xv. 194.—Comparison of suspension bridges with those of the girder construction, for use on railways, xvi. 478, 478.

Bust of, presented (Baily, E. H.), xii. 111.

Canals versus railways, as a means of conveyance, and instances of their working in competition and in co-operation, in the metropolis, xvii. 406.

Chronometric governor, Messrs. Siemens', v. 261.

Coal, proposal to estimate the value of, by the amount of carbon which it contains, viii. 110.—Proposed use of, in locomotive engines, 111.—Original experiment, on the Manchester and Liverpool railway, with anthracite, 112.

Coffer-dams used in laying the lines of water-pipes between Twickenham and Richmond, crossing the river Thames, xiv. 37.—Method of forming a coffer-dam at the Victoria-bridge, across the St. Lawrence, near Montreal, 38.

Colliers, comparative advantage and cost of screw and sailing, xiv. 871.—Balancing, 372.

Concrete blocks at Marseilles and at Algiers, xvi. 447.

Death of, notice of the, by Mr. J. Locke,

STEPHENSON.

- M.P., President, at the opening of the session, xix. 2.—Ditto in Annual Report, 164.—Ditto, by Mr. G. P. Bidder, on taking the chair for the first time after his election as President, 216.
- Diving apparatus, xv. 347.
- Diving dresses, improvements in, xv. 340.
- Docks, Sunderland, the construction of the coffer-dams, and system of scouring; to prevent the formation of a bar at the sea entrance, xv. 445, 455.
- Drainage of land. Catch-water drains, iv. 201.
- Drainage of towns. Relative advantage of pipe and brick drains, xi. 420.—Drainage of the metropolis, xii. 84.—Use of small pipe-drains and their supposed advantages, 86.
- Engines. Difference between the theoretical and practical results obtained from the carbonic acid gas engine, ix. 200.—Du Trembley's combined-vapour engine, xviii. 272, 274.
- Fire-proof buildings. Form of construction adopted in Messrs. Gray's mill, at Manchester, vi. 223.—Construction and cohesive strength of cast iron diminished at high temperatures, viii. 155.—Measures taken to protect from fire a large cotton-mill at Oldham, 159.
- Fluids, resistance to bodies moving in. Method for determining the relation between the velocity and the resistance, v. 280.—The marine engine might be used as a dynamometer for ascertaining the resistance, 480.
- Foundations in India, method of obtaining, xvi. 455.
- Foundations under water. Machine used, under the direction of Mougel Bey, for excavating the barrage of the Nile, x. 368.—Compressed air process employed in sinking the protecting cylinders, at the heads of the jetties of the steam-ferry over the river Nile, at Kaffre Azzayat, xvii. 64.
- Fuel. Combustion of under boilers, and absorption of heat, xi. 400.—Slow and rapid combustion, 401; xii. 415.—Simple combustion, 415.
- Girders. Formula for calculating the

STEPHENSON.

- strength of, vi. 223.—Construction of railway bridges, 224.—Warren girders. Newark Dyke bridge, Great Northern railway, xii. 610.—Direction of strains in sides of girders, xiv. 469, 484.—Trellis and Warren girders, and difference between them, 471.
- Heat, latent, of water and steam, viii. 113.—Unit of heat now employed by scientific men, xvi. 421.
- Horse power of engines, uniform system of determining, x. 309, 310, 311.
- Isthmus of Panamá, ix. 72, 81; xv. 416.
- Isthmus of Suez, survey of the, made in conjunction with M. Talabot and M. de Negrelli, with the view of testing the accuracy of the levels previously taken, x. 376.—Project of Linant Bey for carrying a canal from the Red Sea, through the Bitter Lakes, to Lake Timsah, and thence through the lagoons of Lake Menzaleh, to Tineh (Pelusium), in the Mediterranean, 377.—Geological features of ridge between the Red Sea and the Bitter Lakes, 380.
- Liquid hydrocarbons; application of certain, to the purposes of artificial illumination, and as to gazogène-lamps, viii. 232.
- Locks, Old Ford, cast-iron pointing-cill at, xvii. 407.
- Locks and keys. Inutility of taking an impression from the bellies of the tumblers of a lock, ix. 336, 339, 342.
- Locomotive boilers. Practical identity of fire-box and tube surface for evaporating action, xii. 416.—Comparison of long with short boiler experiments, 416.
- Locomotive engines. Effect of placing the driving-wheels behind the fire-box, viii. 241, 246, 250, 252.—Long-boiler engine with outside cylinders, and axles all confined within the fire and smoke boxes, 241, 255.—Question of outside, or inside cylinders, 241.—Best position for the driving-wheels, 246, 247, 250.—Comparative advantages of large and small wheels, 258.—Proportion of the length of stroke to the capacity of the cylinder, 260.—Want of analogy be-

STEPHENSON.

tween the 'Planet' locomotive-engine with a multitubular-boiler, blast-pipe, horizontal-cylinders, and cranked-axes, and the 'Liverpool,' xvi. 23.

Machines. Self-acting tools employed in the manufacture of engines and machinery, and particularly as to a key-grooving machine, xvii. 192.

Masonry. Practice of mixing rubble work with ashlar, and character of masonry of Royal Border bridge, Newcastle, x. 237.—What is really rubble, 238.—Weight which masonry will bear, 241.

Mental calculation, Mr. Bidder's oral address on, xv. 251, 280.

Metal, Stirling's, xviii. 361.

Mines. Government inspection of collieries, vi. 186, 203.—Proposed improvements in the ventilation of, 187, 202.—Safety-lamps, 188.—Causes of accidents, 196.—Extract from Mr. Gibbons' Treatise on the Ventilation of Mines, describing the system adopted by him at the Shut End Colliery, Staffordshire, 197.—Chief features of ditto, 202.—Dangers to be apprehended from the 'goaf,' 205.—Explosive gases of mines, 210.—Safety-lamps of Dr. Reid Clanny, Mr. G. Stephenson, and Sir Humphry Davy, 211.—Diminution in the loss of human life in coal-mines in Great Britain, viii. 136.—Ventilation of mines, 136.—Government interference in mining operations, 137; xii. 306.—Quantity of air necessary for a mine, 307.—Term 'natural ventilation,' 308.—System of exhausting, preferable to that of forcing in air, 308.—Application of gas for lighting mines, and its probable use in collieries, xvii. 15.

Motive power, application of voltaic electricity as a, xvi. 420.

Permanent way. Cost of maintenance, xi. 296.—Chief causes of deterioration, 298.—Rails for Egyptian railway, 464. Railway accidents do not arise from broken rails, 475.—Duration of railway points, switches, and crossings, xiv. 434.—Construction of ditto, 434,

STEPHENSON.

435.—Standard of traffic on railways, in respect of wear and tear, 436.

Piles for foundations of the bridges over the river Don and canal, at Sprothro', x. 306.

Railway, atmospheric, iv. 261.—Method of performing the experiments for his report, 262.—Dr. Robinson's opinion as to the maximum velocity to be arrived at, 263.—Remarks, 264.—Experiments and deductions contained in his report, 269.

Railway companies, as manufacturers of rails and locomotives, xi. 462.

Railway-ferry over the Nile, at Kaffre Azzayat, xvii. 64.—Comparison with the floating-bridges at Plymouth and Portsmouth, constructed by the late Mr. Rendel, 66.—Employment of steam-ferries for the passage of the rivers of India, 67.

Railway inclines, arguments for and against, x. 253.—Value of good gradients, in some cases, as for instance, on the railway from Newcastle to York, 253.—Ascent of incline planes by locomotive engines, 253.—Incline plane at Liège, 254.—Gradient to be adopted depends on nature of traffic, 256.

Railway trains, resistances to, and methods of measuring the amount, with remarks as to the experiments instituted by the British Association, v. 418, 420, 432.—Amount arising from the concussions of the impinging of the wheels against the rails, 422.—Proposed experiments, on the resistance to traction, on the Epsom line (atmospheric), 426.—Mode of conducting experiments for ascertaining, and experiments on inclined planes, vii. 314, 320, 324, 325.

Railways, twisting of the rope on the London and Blackwall, v. 156, 158.—Use of condensing engines, 157.—Expense of working, 158.—Extracts from Second Report of Postmaster-General on the Post-office, relative to the postal effects of railways, xv. 456.—Reply to ditto, 470.—Defects in the general arrangements for the goods and

STEPHENSON.

- passenger traffic on the Egyptian railway, xvii. 66.
- Retaining walls of the Euston incline, London and Birmingham railway, iv. 83.—Construction of retaining walls, 85.
- Rivers and estuaries. Improvements in the Severn, iv. 112.—Barrage of the Nile, x. 379.—Treatment of rivers, xii. 12.—Norfolk estuary, 13.—Depth of deposit in the bed of the Nile, and rate of current in that river, xvii. 65.—Probable effect of the Tyne docks, and of other works, upon the régime of the river Tyne, xviii. 522, 523.
- Roofs, calculation of the weight of, xiv. 270.
- Sea defences. Temporary groynes erected at Penmaen Mawr, vi. 124.
- Sea-walls and embankments, construction of, vi. 115.—Sea-walls at Penmaen Mawr, on the line of the Chester and Holyhead railway, 115.—Effects of a storm and means of prevention in future, 116.—Dymchurch wall, 123.—Sea-walls at Penmaen Mawr, and works for carrying railways along a sea-shore, x. 274.—Relative advantages of a perpendicular, or a sloping wall, 274.—Difference between sea-walls at Alderney and at Penmaen Mawr, 276.
- Ships and steam vessels. Ballasting vessels with water, xiv. 349.
- Steam, assumption that it is a permanently elastic fluid, v. 429.
- Steam boilers, means of preventing the incrustation of, and process adopted on the Birmingham and Derby railway, v. 205.—Effects of the application of muriate of ammonia, 209, 214.—Priming in boilers, and difference in the action of high and low pressure steam, viii. 182.—Preventing incrustation in boilers, 183.—Boutigny's diaphragm boiler, xi. 401.—Advantage of tubular boilers for steam vessels, 401.—Heat trap of Lord Dundonald's boiler, 401.—Various theories which have been suggested to account for explosions in steam boilers, xv. 307.
- Steam navigation, &c. Pitched chain

STEVENSON.

- for connecting the driving machinery with the screw shaft in the 'Great Britain' steam ship, iv. 170.
- Stone, artificial, manufacture of, with a silica base, and use of that material for architectural ornaments, vii. 63.
- Water, flow of, through pipes, experiments for determining, xiv. 290.
- Water-mains, joints of, xiv. 41.
- Water supply to Liverpool, xii. 504.—Depression of water-level, and infiltration of salt-water into springs under Liverpool and London, xiv. 521.
- Weirs. Supposed advantages of an oblique, over a square weir, v. 351, 355.
- STEPHENSON, Sir M. [Member of Council, xvi. 88.]
- Stephenson's theatre machinery, description of, (Birch, J. B.), i. (1841) 153.
- STEVENS, J. J. [Election, i. (1840) 105.]
- Gas meters, iv. 219.
- STEVENS, J. L.
- Furnaces, admission of air to, xiv. 24, 28.
- Smoke, prevention of, his apparatus for, xiv. 24.
- STEVENSON, A.
- Rivers and estuaries. Measurements of the summer discharge of the river at Conan bridge, and observations as to the under-currents flowing into and out of the Frith of Cromarty (Murray, J.), xx. 329.
- STEVENSON, D. [Telford premium, ii. (1842) 9; election, iii. 342.]
- Coffer-dams. "Description of a coffer-dam used in excavating rock from the navigable channel of the river Ribble," i. (1841) 81.
- Rivers and estuaries. His observations on the Frith of Dornoch in 1842 (Murray, J.), xx. 323.
- Timber, creosoted for marine works, and specimen of creosoted Memel timber, from Scrabster harbour, attacked by the worm, xviii. 436.
- STEVENSON, G. W. [Election, x. 293.]
- STEVENSON, R. [Memoir, x. 94.]
- Cranes, moveable beam, used in the erection of the Bell Rock light-house

STEVENSON.

in the year 1808, iv. 339, 341.—Balance crane ditto, 340, 342.

North Sea. Reference to his Paper "On the Bed of the North Sea," *Edin. Phil. Jour.* 1860 (Bruff, P.); xx. 358, *et seq.*

STEVENSON, T.

Levelling. "Description of an improved levelling staff, and a modification of the common level," i. (1841) 130.

Lighthouses. Proposed use of porcelain reflectors xv. 25.—Holophotal system of illuminating, 25.

Waves, action of, his observations, by means of a dynamometer on the (Russell J. S.), vi. 142.

STEWART, —.

Arches, failure of, v. 464.

STICKNEY, R. A. [Election, viii. 164.]

STILEMAN, F. C. [Election, xiv. 374; Auditor, xx. 107; Council premium, 123.]

Tunnels. "On the construction and enlargement of the Lindal tunnel, on the Furness railway," xix. 229.—Remarks, 238.—Cost, 238, 239.

STIRLING, J.

Air engines. "Description of Stirling's improved air engine," iv. 348.—Remarks, 355.—Explanation of the model, 355.—Economy of the system, 356.—Relation between it and ordinary steam engines, 357.—Indicator diagrams taken from it, 357.—Explanation of certain parts, 357, 358.—Consumption of coal per horse power, 359.—Leading principle of the engine, 359, 361.—Means used to prevent leakage, 360.

— Caloric, or heated-air engine, xii. 599.

STIRLING, J. D. M. [Election, ix. 232; resignation, xvi. 98.]

Iron, toughened, used for viaduct at Manchester (Jee, A. S.); xi. 226.—Remarks, 238.—Experiments of Mr. E. Hodgkinson, on the comparative increased strength and tenacity of toughened iron, 239.—Increase of strength obtained by an admixture of wrought iron with cast iron, (Rennie, G.), xviii. 357, *et seq.*

STONE.

Stirling's air engine, iv. 348, *et seq.* *Vide also* AIR ENGINES.

— bucket water meter, 59.

STOCKMAN, B. P. [Election, xiv. 374.]

STODDART, Colonel. [Memoir, iii. 26.]

STOKES, J. F. [Election, xix. 130.]

STONE, ARTIFICIAL.

"On the manufacture of artificial stone, with a silica base." By F. Ransome, vii. 57.—Description of the process, 57.—Changes which take place during the operation, 58.—Chief peculiarity which distinguishes this from other artificial stones, 58.—Experiments upon its strength, 59.—Remarks as to its durability, 59.

Discussion.—Barry, C., 66.—Buckland, Dr., 66.—Carpmael, W., 70.—De la Beche, Sir H., 67.—Donaldson, Prof., 63.—Faraday, Dr., 60, 61, 64.—Farey, J., 63.—Gaird, Dr., 65, 69.—Hawkins, J. L., 70.—May, C., 69.—Newton, W., 70.—Pellatt, A., 61, 63, 65.—Phillips, R., 68.—Ransome, F., 59, 64, 65, 68.—Rendel, J. M., 68.—Smith, C. H., 61.—Stephenson, R., 63.—Walker, J., 67, 69.

Stone-boring machine, Hunter's, ii. (1842) 146.

— pipes, experiments on the strength of, by Mr. Telford, for the Glasgow water-works, ii. (1843) 136.

— planing machine, Hunter's, i. (1837) 38.

STONES.

"On the strata of stone in the neighbourhood of Whithby." By N. King, i. (1838) 20.

Specific gravity, or weight, of different building stones (Smith, C. H.), vii. 200.

— Experiments on the resistance to vertical pressure (Bruce, G. B.), x. 243.

Vide also PAVEMENTS.

STONEV, B. B. [Election, xvii. 128.]

Beacons, floating. "On the construction of floating beacons," xx. 300.—Remarks, 311.—Keel buoys already constructed, and as to that form being considered a simple modification of Herbert's cone-bottomed buoy, 311.

STOREY.

STOREY, J.

Bridges. "Description of cast and wrought iron trussed-girder bridges on the line of the Bishop Auckland and Weardale railway," iii. 58.

— "Description of an oblique bridge over the river Gaunless, on the Hagger Leases branch railway, Durham," iv. 59.

STOREY, T. [Memoir, xix. 182.]

STOTHEBT, —.

Drainage of towns. Extracts from his account of experiments on deodorizing sewage-water (Bidder, G. P.), xii. 90.

STRAPP, J. [Election, xiii. 190.]

Permanent way of the South-Western railway, xvi. 382.—Trial length of Mr. Seaton's way, xx. 282.

Roof at Nine Elms station, South-Western railway, xiv. 267.

STREET CLEANING.

Sweeping machine (Whitworth, J.), ii. (1843) 203.

"On the advantages and economy of maintaining a high degree of cleanliness in streets and roads, with an account of the construction and operation of the street-sweeping machine." By J. Whitworth, vi. 431.—General advantages of street cleanliness, 431.—Annoyances of the common system of street cleansing, 432.—Importance of water in street cleansing, 433.—Proposed arrangement for rendering street sweeping, in wet weather, more economical, 434.—Description of the street-sweeping machine, 435.—Economy of the machine increases in proportion to the cleanliness maintained, 438.—A large number of machines can perform a larger proportionate amount of sweeping than a smaller number, 439.—What number of machines are desirable for cleansing a town, 440.—The cleansing of the footpaths should not be left to individuals, 442.—The impolicy of employing paupers as scavengers, 443.—The wear and tear of the roadway diminished by more frequent cleansing, 446.—The draught of carriages diminished by increased cleanliness, 447.—The proper form and

STRUVE.

construction of roadway and channels, 449.—General summary of the advantages machine sweeping possesses over hand sweeping, 450.—Appendix, comparative trial of hand and machine cleansing in Salford, 451.—Ditto, street cleansing in Birmingham, 453.

Discussion.—Chadwick, E., 455.—Farey, J., 462.—Holland, P. H., 460.

Street railways in United States, xi. 269.

Streets, description of an improved mode of paving, (Lomax, E.), i. (1841) 131.

— of the metropolis, present state of the, and the importance of their amelioration (Cochrane, C.), ii. (1843) 202.

— of towns, on macadamized roads, for the, (Smith, J. P.), xiii. 221.

—, *Vide also* PAVEMENTS; ROADS; and STREET CLEANING.

Strength of cast iron, on the increased, produced by the use of improved coke (Calvert, F. C.), xii. 352.

— of materials; details of some experiments for determining the position of the neutral axis of rectangular beams of cast and wrought iron and wood, and also for ascertaining the relative amount of compression and extension at their upper and under surfaces, when subjected to transverse strain (Colthurst, J.), i. (1841) 118.

—, Mr. George Rennie's experiments upon the, v. 34.

STRIKLAND, W. [Election, ii. (1842) 138; resignation, xiii. 183.]

STRODE, W. [Election, ix. 182.]

Fire-arms. Enfield rifle, xix. 376.

Gas. Comparative quantities of gas made by iron and by clay retorts, xvi. 320.

STRUTHERS, J. [Election, ii. (1842) 138; resignation, xiii. 134.]

STRUVÉ, W. P. [Election, viii. 164; Telford medal, xi. 87.]

Mine-ventilator, application of his, at the Eaglesbush Colliery (Smyth, W.), viii. 129.

Mines. "The ventilation of collieries, theoretically and practically considered," x. 22.—Remarks, 38.—Description of his mine-ventilator, 38, *et seq.*—Principles to be observed in the in-

STRUVE.

ternal arrangement of collieries, 55.—
Conditions necessary to be observed to maintain a velocity of 18 feet per second in the upcast pit of every colliery, 55.—Trials of the efficacy of the steam-jet at the Tyr Oenal and Margam collieries, near Swansea, 56.—M. Combe's opinion as to applying the steam-jet at the top of the upcast shaft, 56.—Amount of ventilation that might be produced by the mine-ventilator, 57.

Struve's mine ventilator, vi. 171.

STUART, the Hon. M.

Sea defences. "On sea defences constructed with peat-moss," i. (1841) 140.

STUART, W. [Memoir, xiv. 137.]

Blasting. "On the limestone, the lime cement, and method of blasting, in the neighbourhood of Plymouth," i. (1838) 35.

Breakwaters. "Account of the original construction and present state of the Plymouth breakwater," i. (1841) 160.

STUBBS, W. [Election, xx. 586.]

Submarine electric telegraphs, on, (Window, F. R.), xvi. 188.

—, Atlantic, Mediterranean, and intended Red Sea, noticed in Annual Report, xvii. 71.

—, extension of, xviii. 169; xix. 141, 221.

— *Vide also* ELECTRIC TELEGRAPH; and TELEGRAPH CABLES.

Submarine foundations, on, particularly the screw-pile and moorings (Mitchell, A.), vii. 108.

Suez, on the Isthmus of, and the canals of Egypt (Glynn, J.), x. 369.

SULLIVAN, Captain.

Defences, national. Extract from his evidence, taken before the Defence Commissioners, as to steam rams (Bidder, G. P.), xx. 520.

SULLIVAN, J.

Meters. His dry meter (Croll, A. A.), iv. 216.

Sulphur, the action of, upon the chimneys of lamps, ii. (1843) 189.

Sulphuric and sulphurous acid evolved from lamp-burners, injurious to the furniture of rooms, &c., ii. (1843) 188.

SWINBURNE.

Sunderland harbour, account of the removal of the lighthouse at (Murray, J.), iii. 342.

—, an account of the progressive improvement of, and the river Wear (Murray, J.), vi. 256.

Superheated steam, xix. 463, 464.

Surface condensation. *Vide* COMBINED VAPOUR ENGINE.

Surf-wave, effect of, vi. 126.

Surveying, v. 112.

SURVEYING INSTRUMENTS.

"An azimuth cap as an addition to the common level." By E. Cowper, i. (1840) 31.

"Description of an instrument for describing the profile of roads." By H. Carr, i. (1840) 56.

"Description of an instrument for describing the profile of roads." By H. Chapman, i. (1840) 86.

Clinometer (Grantham, R. B.), v. 480.

"Description of the prismatic clinometer, a new pocket instrument for measuring vertical angles." By W. Pole, xi. 23.
—Use of sextant at sea, in conjunction with artificial horizon, 23.—Sir J. Macneill's effort to dispense with the artificial horizon, by attaching a small spirit bubble to the sextant, 24.—Plummets instrument for measuring vertical angles roughly, 24.—Capt. Kater's prismatic azimuth compass, 24.—Adaptation to measurement of vertical angles, 26.—Advantages of instrument so constructed, 26.—Practical applications, 27.—Combination with prismatic compass, and application to determine height of Staubbach water-fall, 27.

Surveying signals; notice of those employed in America, i. (1837) 19.

Suspension bridges, *Vide* BRIDGES, SUSPENSION.

SWANN, W. [Election, viii. 164; Auditor, ix. 90; x. 59.]

SWANWICK, F. [Election, vi. 431.]

SWINBURNE, H. [Telford medal, xi. 87.]

Sea walls. "Account of the sea walls at Penmaen Mawr, on the line of the Chester and Holyhead railway," x. 257.

SWITCHES.

Switches, self-acting, on railways, accidents arising from use of, xi. 439.

— and crossings, railway, Faram's, iii. 127; Carr's, xiii. 437; Burleigh's, xiv. 419; Hurry's, xvi. 298; Ransome and Biddell's solid chilled crossing, 299.

SYME.

SYLVESTER, J. J. [Election, i. (1838) 21; memoir, xii. 165.]

SYME, J. T.

Bridges. "Description of the bridge over the Whitadder, at Allanton (Berwick)," iii. 101.

T.

TABBERNER.

TABBERNER, J. L.

- Water supply. Depression and alternation of the water-level under London, ix. 175.—Saline properties of chalk water, 175.
- Wells at Trafalgar Square, ix. 169.—Cause of the diminution of the water in Messrs. Barclay's well, 169.
- Table of velocities of steam ships, i. (1841) 67, 68.
- showing the power required to obtain various rates of speed in a steam-vessel, i. (1841) 72.
- of the dimensions and proportions of forty iron vessels, (Kendall, Lieut. E. N.) i. (1841) 146.
- of experiments on the Tyler Hill inclined plane, Canterbury and Whitstable railway, showing the relative amount of lost power by the rope traction, as compared with that of the atmospheric system, on the Dalkey inclined plane, iv. 126; 142.
- of experiments with several forms of screw propellers, iv. 156.
- of the length, period, and velocity of transmission of waves, vi. 137.
- of rainfall and percolation through Dalton's gauges, filled with surface soil and chalk, at Nash Mills, Hertfordshire, from October 1833 to December 1860, xx. 222.
- of experiments on the vertical stiffness of rails and rolled rail-bearers of different sections and combinations, xx. 274.
- Table Bay, Cape of Good Hope, proposed wave screen, xix. 647, *et seq.*
- Talbot's electro-magnetic engine, xvi. 391.
- Tamping, on, i. (1838) 84.
- Tank, Coradino, at Malta, ii. (1843) 140.
- Tanks for Kyanizing timber, (Timperley, J.), ii. (1842) 80.
- TASKER, J. H. [Election, iii. 173; memoir, xi. 109.]

TAYLOR.

TATE, T.

Steam. "On the law of the expansion of steam," vi. 343.

TAUNTON, J. H. [Election, xi. 68.]

TAYLOR, —.

Mines. Desirability of miners being properly educated, and of the best system of ventilation being decided upon, viii. 134.

TAYLOR, F. [Election, i. (1841) 87.]

TAYLOR, G. [Election, xx. 292.]

TAYLOR, G. L. [Election, ii. (1843) 68; resignation, xviii. 182.]

TAYLOR, H.

Decimal coinage, xiii. 282.

TAYLOR, J. [Election, i. (1839) 33; Member of Council, ii. (1842) 51; (1843) 67; iii. 66; iv. 62; v. 142; resignation, ix. 97.]

Coke ovens, i. (1839) 41.

Datum line, establishment of a general, throughout England, v. 312.

Engines, friction of pumping, ii. (1843) 70.

Hydraulic engines, ii. (1843) 144.

Iron, smelting, with anthracite, ii. (1842) 62. — Rapid changes of cast-iron pipes in copper mines, 153.—Clay's process of making iron, (1843) 85, 86, 87.—Injury received by iron in working, 93.—Destruction of cast-iron pump-trees when exposed to the action of mine-water, vii. 158.

Iron ores, hematite, iii. 245.

Mines. "Description of a machine for raising and lowering miners," ii. (1843) 193.—Remarks, 194.—Slade's machine, 195.

—, ventilation of, vi. 184, 190.

Pump-valves, ii. (1843) 198; iii. 91.

Railway, atmospheric, friction of the air within the tube, iv. 280.

Railway cuttings, iii. 150.

Ships and steam vessels. Copper sheathing, ii. (1842) 69.

TAYLOR.

- Timber. Chemical action in Kyanizing timber, ii. (1842) 84.—Dr. Boucherie's process for preserving timber, 87.
- Turbine, ii. (1842) 96, 101.
- Water, temperature of, in wells and mines, ii. (1843) 141, 142.
- Water-wheels at Wheal Betsy and Wheal Friendship, ii. (1842) 96. — Water-wheels (1843) 64; iii. 68.
- Well sinking, ii. (1843) 59.
- TAYLOR, J., JUN. [Election, v. 338.]
- Fuel, perfect combustion of, under boilers, v. 368.
- Gold. Theory of the vertical structure of gold-bearing rocks, xv. 58.—Machinery employed for extracting gold, 59.—Three specimens of gold quartz, 61.—Alchymists of old, 62.
- Metals. Importance of effective machinery for separating valuable ores, xvii. 214.—Quantity of stuff raised at the Polberro Tin Mines, the quantity stamped, and the average yield of tin per ton of stuff, 214.—Crushing-machine, 215.—Processes for removing wolfram from tin, 219.—Application of the principle of the coal-washing machine to metallurgic purposes, 220.
- Mines. Legislative interference in, vi. 188.—Ventilation of, 189.
- TAYLOR, JOHN. [Election, vii. 366.]
- TAYLOR, JOSEPH. [Election, xix. 130.]
- TAYLOR, P.
- Iron, cast, changes of, in low-pressure steam engines when galvanic action is excited, ii. (1842) 153.—Change suffered by cast iron when in contact with gun-metal, vii. 158.—Decay of cast iron in coal-mines, 158.
- Pipes. Destruction of copper pipes in the bilge water of vessels, ii. (1842) 154.
- Ships and steam vessels. French steam ship 'Napoléon,' iv. 171.
- TAYLOR, T. H. [Election, xx. 375.]
- TAYLOR, W. [Election, ix. 303; Telford medal, x. 65; resignation, xvii. 85.]
- Paving. "Observations on the street-paving of the metropolis; with an account of a peculiar system adopted at the London and North-Western railway station, Euston Square," ix. 214.—

TELEGRAPH CABLES.

- Remarks, 230.—Metropolitan paving, 230.—Term 'partially elastic foundation,' 230.—Inapplicability of macadamized roads for cities, 230.—Specimen of Euston pavement laid in Watling-street, 231.—Llangollen slate stone for flagging streets, 232.
- Paving. Cost of paving at Birmingham, xiii. 239.—Comparative cost of paved and macadamized roads, including first cost, repairs, and cleansing, 239.—Suitability of macadamizing for turnpike-roads, 240.
- TAYLOR, REV. W.
- Bells, large, of Europe (James. J.), xix. 10.
- Taylor's water-meter, xiii. 425.
- Tea, application of the hydrostatic percolator to making, xiii. 419.
- Teeth of wheels, on a method of setting out involute (Cowper, E.), i. (1841) 60.
- Telegraph for railway trains, iron, xvii. 539.
- TELEGRAPH CABLES.
- Proposed Atlantic (Annual Report), xvi. 91.—Probable time one word will occupy in transmission, 201.—Assumed difficulty of working at a commercial rate, 203, *et seq.*
- "On submarine electric telegraphs." By F. R. Window, xvi. 188.—First mention of insulating wires, so as to conduct an electric current, when submerged in water, 188.—Non-conducting qualities of gutta-percha, and its fitness for insulating telegraph-wires, 189.—First experiment with gutta-percha covered wires, off Folkestone harbour, 190.—Concessions, by French Government, for submarine telegraph between England and France, 190.—Failure of the gutta-percha covered wire, laid from near Dover to Cape Grisnez, 190.—Concession under which Submarine Telegraph Company now works, 191.—Laying of the submarine telegraph-cable between Dover and Calais by Mr. Crampton, 191.—Failure in three subsequent attempts to connect England and Ireland by a submarine telegraph, 192.—Laying of the Dover and Ostend cable, 192.—From Port Patrick to

TELEGRAPH CABLES.

Donaghadee, 192.—Between England and Holland, 192.—From Spezia to Corsica, 193.—All great marine telegraphs laid during bad weather, 193.—Construction of a telegraph-cable, 194.—Tabular description of the construction of the principal submarine cables in existence, arranged chronologically, 194.—Main idea, or principle, in these cables, 194.—Different principle adopted in cable laid down by International Telegraph Company, 194.—Passage of electricity by submerged wires, as compared with that by suspended wires, 196.—Difference in regard to time, in the conducting powers of submerged and suspended wires, 197.—Table of the measured velocities of electricity upon metallic conductors, 198.—Mr. L. Clark's experiments as to the passage of electricity through underground wires, 198.—Longer time occupied by the discharge than the charge, 201.—Difference in working electric telegraphs upon suspended and submarine—Probable time one word will occupy wires, in transmission between Ireland and America, 201.

Discussion.—Bidder, G. P., 218.—Bright, Sir C., 203, 209, 223.—Clark, L., 211.—Crampton, T. R., 205, 224.—Faraday, Professor, 220.—Fox, Sir C., 218.—Hemans, G. W., 223.—Highton, E., 222.—Phipps, G. H., 224.—Siemens, C. W., 218.—Thomson, Professor W., 210.—Varley, C., 213.—Whitehouse, W., 215.—Window, F. R., 203, 207.

"On submerging telegraph cables." By J. A. Longridge, and O. H. Brooks, xvii. 221.—Questions to be discussed, 222.—I. Is it possible to lay a cable straight along the bottom, in deep water, free from the action of currents? 223.—Tables giving the angle of inclination of the cable to the horizon, and the waste in paying out for the Atlantic cable, and one of the specific gravity of 1.5, 225.—II. What degree of tension is required in paying out, so as to lay the cable straight? 228.—III.

TELEGRAPH CABLES.

What is the effect on the cable, as regards strain, of varying (a) the depth of the water, (b) the specific gravity of the cable, and (c) the velocity of the paying-out vessel? 229.—IV. What are the relative velocities of the cable and of the paying-out vessel, requisite to reduce the strain, or tension, to any given amount, and what will be the consequent waste of cable? 229.—V. What is the effect of currents, and the consequent waste of cable? 233.—VI. How far is it necessary and safe to check the velocity of paying out in passing currents, so as to avoid, as far as possible, waste of cable? 236.—VII. Is it safe, and if so, under what circumstances, to stop the paying out, and to attempt to haul in the cable from great depths? 236.—Tables showing the strain brought upon the cable by stopping the paying out in a depth of 2,000 fathoms, and also the length to be payed out to produce a minimum tension, 237.—VIII. What is the effect of the vessel pitching in a heavy sea? 239.—IX. What are the desiderata in the paying-out apparatus? 239.—X. What would be the effect of floats, or resistors? 240.—XI. What are the best means of saving the cable, in case of fracture? 240.—XII. What is the best mechanical construction of a submarine telegraph cable? 244.—Appendix. Prob. I. Equations of motion of a body descending in a resisting medium, 249.—Prob. II. Equations of motion of a body descending uniformly, in an oblique position, through a resisting medium, 250.—Prob. III. General equation to the curve assumed by the sinking cable, 251.—Prob. IV. Equation for tension, 254.—Tables showing the tensions in lbs. for varying velocities of the vessel, angles of inclination, and ratio of paying out to velocity of vessel, for the Atlantic cable, and one of the specific gravity of 1.5, 255.—Prob. V. To find the waste of cable from currents, 255.—Prob. VI. Equation to the curve assumed by a flexible

TELEGRAPH CABLES.

line stretched across a current, 256.—Prob. VII. To find the tension due to the friction of the water in a current 257.—Prob. VIII. To find the form the cable will assume, and the tension, in case the paying-out vessel and the paying-out should be suddenly stopped, 257.—Prob. IX. To find the depth of the cable below a following vessel, at any interval after fracture, 258.—Tables for two cables, at various speeds of paying out, 258.—Prob. X. To find the extension of length due to the compression of the inner core, 260.—Prob. XI. To find the variation of tension due to the motion caused by waves, 260.

"On the practical operations connected with paying out and repairing submarine telegraph cables." By F. C. Webb, xvii. 262.—First submarine cable from Dover to Cape Grinez, 263.—Construction and laying of the present Dover and Calais cable, 263.—Inconvenience of towing a vessel when paying out a cable, 263.—Cable from Holyhead to Howth, 264.—Ditto Portpatrick to Donaghadee, 264.—Break employed in laying ditto, 264.—Cable from the South Foreland to Middlekirke, in Belgium, 264.—Detailed description of the cables belonging to the International Telegraph Company, 264.—Single cable system decided on, 265.—Compound cables for the shore-ends, 265.—Testing for insulation during the manufacture of the cables, 266.—How coiled on board the 'Monarch,' 266.—Line buoyed off previous to laying the first cable, 266.—Cables from Holyhead to Howth, belonging to the Electric Telegraph Company, 268.—On laying submarine cables, 268.—Is a screw, or a paddle-wheel steamer to be preferred, 268.—Disposition of the cable on board, 268.—Coiling ropes, showing the position of the 'turn,' 269.—Relative advantages of circular and oblong coils, 270.—Liability of a 'foul fake' arising with oblong coils, 270.—Evils of hollow centres in circular coils, 271.—Mr. Newall's cone and rings for uncoiling a cable,

TELEGRAPH CABLES.

271.—Break generally used to prevent the cable running out, by its own weight, faster than is desirable, 272.—Drum-break used on board the 'Monarch,' in the North Sea and the Irish Channel, 272.—Failures of two cables in the Mediterranean, in 1855 and 1856, arose from insufficient break power, 273.—Break designed for the Atlantic cable, as fitted on board H.M.S. 'Agamemnon' and U.S.S. 'Niagara,' 1857, 273.—Attendance on the break a position of considerable responsibility in deep water, 273.—Necessity of tests for insulation when paying out, 274.—Reception of a current simply, relied on when paying out the Atlantic cable in 1857, 275.—Cables in the Mediterranean, between Cagliari, Malta, and Corfu, tested every twenty minutes, when being payed out, 275.—No cable should be taken to sea, without its insulation having been tested, by the cable being submerged in its entirety, 275.—Experiments as to the strength of galvanized and ungalvanized wire, 276.—On the steering of vessels across tideways, for the purpose of paying out submarine cables, 276.—Method of obtaining the required rate and direction in which the vessel should be steered across a tide, 278.—Arrangements for buoying the end of a cable, 278.—Ditto in the North Sea, 279.—Buoying arrangements in the Atlantic telegraph expedition of 1857, 279.—As to stopping the egress of the cable when paying out, 279.—Causes tending to affect the steering of a ship, and to swing her stern to wind or tide, 281.—Effect of paying out a vessel from the stern on the steerage of vessels, 281.—Projection of a cable through a surface current, 282.—Effect of an under-current, 283.—Plans for overcoming the tendency to swing, 284.—Cause of the loss of cables in deep water, 284.—Curve assumed by the cable in paying out, 285.—An efficient staff of more importance than mechanical arrangements for paying out a cable, 285.—On re-

TELEGRAPH CABLES.

pairing submarine cables, 287.—Details of the mode of executing the repairs of the Hague and other cables, 288.—Testing for faults by means of resistance and return currents, 288.—Mode of measuring the dynamic effect of the static charge, or the return current, 290.—Underrunning, 291.—Ditto the Hague cables in a Dutch fishing-schuyt, in the winter of 1854-55, 292.—Grappling for an end, 292.—Picking-up apparatus used for the Hague cables, 293.—Nun-buoy and mushroom-anchor for buoying an end, 293.—Flag-buoys, 294.—Operations on the Hague cable in May, 1856, 294.—Position of the Hague cables in 1857, 296.—Operations for procuring the cable outside the ridges, or sand-banks, in which it was buried, 296.

Discussion.—Airy, Prof., 298, 302, 359, 366.—Allan, T., 315, 322.—Atkinson, J. S., 334.—Bidder, G. P., 332, 365.—Brett, J. W., 307, 321.—Bright, Sir C. T., 302.—Browning, C. E., 332.—Clark, L., 310.—Crampton, T. R., 301, 306.—Field, C. W., 302, 326, 335, 340.—Gisborne, L., 317.—Gregory, C. H., 301.—Highton, E., 314.—Hobbs, A. C., 329.—Hodge, P. B., 340.—Locke, J., 358.—Longridge, J. A., 300, 341, 363.—Macintosh, J., 327, 329.—Rennie, G., 325.—Siemens, C. W., 319.—Varley, S. A., 329.—Webb, F. C., 301, 307, 350.—Wollaston, C. J., 309.

“On the electrical qualifications requisite in long submarine telegraph cables.” By S. A. Varley, xvii. 368.—Laws of conduction and induction, 368.—Quantity and tension of an electric current, 369.—Conclusions arrived at by the projectors of the Atlantic cable examined, 370.—Difference between a Leyden jar and a submarine wire, 371.—Effect of a wire becoming attenuated at any one spot on its conducting power, 372.—Bearing and value of the resistance opposed by the coils of the telegraph instrument, 372.—Bearing of the resistance in the coils to that op-

TELEGRAPH CABLES.

posed by the cable itself, 373.—Action of a galvanic battery, when connected to send a current on a long submarine circuit, 374.—Relations subsisting, telegraphically, between quantity and intensity of electric currents, and probable advantage of using comparatively large dynamic quantities of electricity, 376.—A larger quantity of electricity flows through a wire, however fine, when the surface in each cell is increased, without adding to their number, 379.—Supposition that increasing the delicacy of the instruments will be the same thing as magnifying the wire, a fallacy, 379.—Explanation of the results of experiments instituted by the Atlantic Telegraph Company, 380.—Is the rate of transmission of signals affected, by increasing the number of cells, when a voltaic battery is employed, 381.—Difference between electro-magnetic induced currents, and those obtained direct from the voltaic battery, 383.—Intensity of electro-magnetic induced currents, 384.—Principles on which the construction of a telegraph cable should be based, 384.

“On the maintenance and durability of submarine cables in shallow waters.” By W. H. Preece, xx. 26.—The Channel Islands telegraph, 26.—Geographical position of the islands, 26.—Formation of company, and letting of contract, 27.—Laying of the cable, and description, 27.—Fracture of the cable between Portland Island and Weymouth, 28.—Ditto on the coast of Jersey, showing the necessity for the greatest care in fixing the ends of cables upon rocky shores, 28.—Manner of protecting, strengthening, and fixing the cable at the landing-places on the south end of Guernsey, and on the western side of Alderney, 29.—Severance of the cable by abrasion upon the sharp edge of a rock, in Portland Race, 29.—Explanation of the probable cause of this accident, 30.—Faults due to ‘kinks’ and to abrasion near to Jersey, 31.—Importance of

TELEGRAPH CABLES.

care being observed in landing a cable, especially in shallow water on a rugged coast, 32.—Accidents to the cable off Alderney, 32.—Table giving list of accidents which have occurred to the Channel Islands cable, 33.—Explanations, showing the causes of the fractures, 33.—Effect of the water in oxidising the outside covering, 34.—Cables should be laid slack in shallow water, and present construction of heavy cables defective, 35.—System adopted in repairing the cables, 35.—Testing cables, 36.—Principles employed in testing dependent either upon the laws of resistance, or upon the laws of induction, 37.—Basis of resistance tests the fundamental law of Ohm, 37.—Variation in the specific resistance of different metallic bodies, 38.—Resistance of a wire decreases directly as its length, and inversely as its sectional area, 38.—Resistance coils, 38.—Instruments employed in comparing the resistance of two wires, 39.—Becquerel's common differential galvanometer, 39.—Wheatstone's parallelogram, 39.—Modification of the common differential galvanometer, 40.—Multiplying differential galvanometer, 40.—Laws of induction, as affecting the testing of cables, 41.—Laws relating to the charge, the discharge, and the return current, 42.—Reduction inductometer, employed for measuring and registering the discharge, 44.—Table giving the exact value of the resistance of the end, to any break in the Channel Islands cable, 45.—Sources of error, gas currents and partial faults, 46.—Methods of testing for partial faults, 47.—Character and origin of faults, 48.

Discussion.—Bidder, G. P., 52, 65, 95.—Braithwaite, F., 75.—Bright, Sir C., 69.—Clark, E., 88.—Clark, L., 62, 69.—Daft, T. B., 90.—Fitroy, Admiral, 60.—Forde, H. C., 73.—Hawshaw, J., 49.—Jenkin, F., 81.—Marshall, J. C., 66.—Preece, W. H., 49, 50, 91.—Seward, G., 77.—Siemens, C. W., 53,

'TEREDO NAVALIS.'

72, 90.—Smith, W., 87.—Varley, C. F., 50.—Wallich, Dr., 75.—Webb, F. C., 67.—West, C., 76.

Vide also ELECTRIC TELEGRAPH.

Telegraph, electric. *Vide* ELECTRIC TELEGRAPH.

—, submarine. *Vide* ELECTRIC TELEGRAPH; and TELEGRAPH CABLES.

Telegraphic communication in India, establishment of electric, xvii. 512.

— in New South Wales, Victoria, and South Australia, and with Tasmania, noticed in Annual Report, xx. 110.

TELFORD, T.

Bust of, in marble, by Hollins, recovered for the Institution (Annual Report), xiii. 124.

Life of, publication of the, (Annual Report), i. (1839) 11.

Monument to, (Annual Report), i. (1839) 12.

Pipes, experiments on stone, (Mackain, D.), ii. (1843) 136.

Water-works. As to his being consulted relative to the Glasgow water-works (Mackain, D.), ii. (1843) 135.—Filter recommended by him (Simpson, J.), 137.

Telford and Watt medals, and Council and Manby premiums awarded. *Vide* PREMIUMS.

— estate; accession of funds to Institution from the division of the residuary estate of the late Mr. Telford, x. 71.

— MSS., ii. (1843) 9; iii. 9; iv. 5.

TENNANT, C. [Memoir, i. (1839) 12.]

TENNANT, J.

Gold. Three specimens of gold quartz,

xv. 62.—Geological sections, 63.

Paving Boards, administration of, ix. 229.

Water supply in London, xix. 37.

Tenoning machine, American, xvii. 30.

'Teredo navalis,' effects of the, on Kyanised timber, i. (1840) 69.—Situations where it is found, ii. (1842) 67.—Ravages of, prevented by the use of coal-tar pitch, 67.—Ditto by coal oil, Renwick's patent, 68.

—, remarks on the ravages of, in timber (Davison, R.), ii. (1842) 90.

—, ravages of, prevented by studding

'TEREDO NAVALIS.'

with nails, ii. (1842) 169.—Effect of the pipe worm on some timber piles, iv. 77.—Ravages of, at Sevastopol, vi. 54.—Ditto in fresh water, 54.

'Teredo navalis,' inquiry into the nature and ravages of the, and the means hitherto adopted for preventing its attacks (Paton, J.), ix. 23.

Terneuse, canal of, vi. 112.

Terra-cotta, and its comparison with the artificial stone, made with a silica base, vii. 62, *et seq.*

TERRY, A. R. [Election, xvi. 46.]

Testing machines, on chain cable and timber, (Dunn, T.), xvi. 301.

— Liverpool Corporation, used for experiments on tenaion, and American testing instrument, in the Gun Factory, Woolwich, for experiments on compression of specimens of wrought iron, &c., xviii. 315.

Texel roads, works executed for forming the harbour of Nieuwediep, at the, vi. 104.

THAMES TUNNEL.

"Notice concerning the Thames tunnel."

By R. Beamish, i. (1837) 32.—Notice of various failures, 32.—First proceedings adopted by Mr. Brunel, 32.—Irruption of 1827 noticed, 33.—Abandonment of works for seven years, 33.—Removal of old, and introduction of new, shield, 33.

Discussion.—Brunel, Sir M. I., 33.—Gibbs, J., 35.

Account of the poling boards at, (Brunel, Sir M. I.), i. (1838) 5, 23.—Deleterious gases issuing from the mud of the river, 23.—Some of ditto ignite rapidly, 23.—Workmen dangerously injured by breathing ditto, 23.—Remarks on the shield, 46.—Further progress of the works, and difficulties encountered, i. (1839) 44.

"An account of the actual state of the works at the Thames tunnel, June 23, 1840." By Sir M. I. Brunel, i. (1840) 85.

Borings and nature of the strata at (Buckland, Dr.), i. (1841) 167; ix, 14, *et seq.*—Notice of the completion of

THOMSON.

the work (Walker, J.) ii. (1843) 29.—Further account of the poling boards, and details of the execution of the work (Brunel, Sir M. I.), 80.—Fracture of the 'fleeting bars' used at the, (Gravatt, W.), 93.

Theatre, Covent Garden, decayed bond timbers in the walls of (Albano, B.), vi. 255.

Theatre machinery, Stephenson's, (Birch, J. B.), i. (1841) 158.

THEODOLITES.

"Description of a double telescope theodolite." By N. Beardmore, i. (1841) 96.

Theodolite with the adjuncts required for an altitude and azimuth instrument (Metford, W. E.), xv. 247.

Thermometers, indications of, i. (1838) 12.

—Proposed application of the decimal scale to, xiii. 346.

Thermometric steam gauge (Adie, A. J.) i. (1838) 15.

THOM, R. [Memoir, vii. 7.]

Embankments. "On the formation of embankments for reservoirs to retain water," ii. (1843) 191.

THOMAS, J. L. [Election, xix. 625.]

THOMPSON, —.

Timber. Explanation of the decay of the Kyanizing tanks, ii. (1842) 86.—Strength of the solution used for Kyanizing, 87.

THOMPSON, A. [Election, i. (1838) 15.]

THOMPSON, W. [Election, ii. (1843) 134; memoir, xiv. 152.]

THOMSON, A.

Canal incline-planes. Report of, recommending the incline-plane for adoption on the Monkland canal, for the purpose of taking up empty boats (Lealie, J.), xiii. 213.

THOMPSON, D. [Election, iv. 186.]

Steam engines. Term 'horse power,' proportion of indicated power to be deducted for friction, and formula for giving the horse power of an engine, x. 312.—Elements in the cost of an engine, 314.

Valves, vulcanized india-rubber, xii. 456.—Safety-valves, xv. 42.

THOMSON, J. [Election, i. (1838) 47.]

THOMSON.

- Cranes, iii. 214.
 Railway trains, resistances to, vii. 325.
 Sea-walls, foundations for, situation of, and materials for the construction of, as affecting the design, vii. 197.
 Tides. Experiments for the purpose of ascertaining the mean tide level, and suggestions relative to a general datum line for England, v. 314.
 Weirs. Probable effects of an oblique weir during a flood, v. 356.—Differences between oblique and square weirs, 358.—Discharge of water over oblique and square weirs, 360.
 THOMSON, J. [Election, xviii. 490.]
 THOMSON, J. G. [Walker premium, iv. 4; memoir, xx. 158.]
 Landslip. "Account of the landslip in Ashley cutting, on the line of the Great Western railway," iii. 129.
 Permanent way of the Dublin and Drogheda railway, v. 242, 245.
 Railway cuttings, tunnels, &c., iii. 153.
 THOMSON, Professor W.
 Electric telegraph. Electric conduction through copper, and electric induction across solid insulators, with reference to the rate of transmission of signals through long underground and submarine wires, xvi. 210.
 Electro-motive power. Mr. Joule's researches on the economical production of mechanical effect from chemical forces, xvi. 400.
 THORMAN, E. H. [Election, xx. 258.]
 THORNEYCROFT, G. B. [Election, ix. 232; Telford medal, x. 65; memoir, xi. 110.]
 Iron. "On the manufacture of malleable iron; with the results of experiments on the strength of railway axles," ix. 294.—Remarks, 300, 302.
 Railway axles. Crystallization or granulation of axle bars, and on the forms of railway axles, ix. 300.—Illustrated by reference to the position of the crank pin in steam engines, 302.
 THORNEYCROFT, T. [Election, xi. 478; resignation, xv. 85.]
 THORNTHWAITTE, T.
 Rope-making machinery, Captain Huddart's improvements in, ii. (1842) 58.

TIMBER.

- THOROLD, W. [Resignation, xvii. 85.]
 Bridges. "An account of the failure of the suspension bridge at Great Yarmouth," iv. 291.—Cast-iron swing-bridge over the river Wensum, at Norwich, v. 438.
 Drainage of towns. Separation of storm and surface waters, xi. 414.
 Fires, means of extinguishing. Effect of water on iron beams, viii. 156.
 Governor, in use in the county of Norfolk, for corn-mills, v. 264.
 Harbours, and the means of clearing away accumulations of sand and silt at their entrances, iv. 323.
 Railway cuttings. Drainage of a cutting on the Yarmouth and Norwich railway, iv. 323.
 Rivers and estuaries. Improving the Clyde as a navigation, v. 331.
 Steam boilers. Forms of two boilers mentioned in his communication, "On supplying high-pressure steam boilers with water," v. 215.—Hall's boilers, 216.
 THURSTON, B. W. [Election, xvi. 226.]
 THWAITES, J. [Election, xix. 130.]
 Tidal phenomena of the North Sea, &c., xx. 315, *et seq.*
 Tide flaps used in the drainage at Ipswich, ii. (1843) 184.
 Tides, proposal for a uniform datum for tidal reference all round the coast of England, v. 309, 311, *et seq.*—Rise of the, at various places along the coast of Holland, vi. 105.—Experiments, made under the direction of the late Mr. Frank Forster, on the flux and efflux of the, in the river Thames, xiii. 93.—Difference in the force of the current in the Frith of Tay and at the Hamoaze, 888. *Vide also* COASTS; HARBOURS; NORTH SEA; and RIVERS AND ESTUARIES.
 Tile and brick arches, experiments on the strength of, (Cubitt, T.), i. (1841) 136.
 TIMBER.
 American. "Experiments on the strength of various kinds of American woods, exposed to a transverse strain." By Lieut. Denison, R.E., i. (1837) 26.

TIMBER.

Timber from the north-west coast (Burnell, G. R.), xviii. 294.

— creosoted, assumed inflammability of, (Bethell, J.), xi. 296.—Remarks as to durability of creosoted sleepers, 296.—When thoroughly creosoted, resists the ravages of the sea-worm, (Abernethy, J.), xviii. 438; (Burnell, G. R.), xix. 665; (Bethell, J.), 666.

— decay of, when in contact with stone, i. (1837) 28, 29.—Decay of bond timbers in the walls of Covent Garden theatre, (Albano, B.), vi. 250.

Dowelling. "On a mode of dowelling timber, or of combining it and other materials for general purposes." By Sir M. I. Brunel, i. (1840) 6.

Durability of, instance of a ship forty-five years old, and still seaworthy (Braithwaite, F.), ii. (1843) 180.—Deterioration of, in sea-works in warm climates (Brunles, J.), xix. 664.

Greenheart, capability of, to resist the attacks of the teredo (Burnell, G. R.), xix. 665.

India, properties of some of the, procurable for railway purposes (Berkley, J. J.), xix. 602. *Vide* also RAILWAYS, Great Indian Peninsula.

Kyanized oak boxes for experiments destroyed by the *Linnoria terebrans* (Mallet, R.), ii. (1843) 174.—Kyanized timber, destructive of iron in contact with it, 177.

Kyanizing, process of, i. (1841) 91.

— "Description of the tanks for Kyanizing the timber for the permanent way of the Hull and Selby railway." By J. Timperley, ii. (1842) 80.—Ditto on the Hull and Selby railway, 80.—Tests for ascertaining the amount of saturation, 81.

Discussion.—Bethell, J., 88.—Braithwaite, F., 83, 86.—Brande, Prof., 89.—Bull, W., 86.—Colthurst, J., 84.—Cowper, W., 85.—Cubitt, Sir W., 83. Cubitt, W., 85.—Horne, J., 87.—Martin, H., 85.—May, C., 83, 85.—Moss, —, 84.—Newton, W., 82.—Oldfield, Lieut., 84.—Oldham, T., 81.—Palmer, H. R., 82.—Pasley, Lieut.-Gen. Sir C,

TIMBER.

W., 85.—Seaward, S., 85.—Simpson, J., 82, 83.—Taylor, J., 84, 87.—Thompson, —, 86.—Walker, J., 84.

Preservation of. "On the nature and properties of timber, with descriptive particulars of several methods, now in use, for its preservation from decay." By H. P. Burt, xii. 206.—On dry rot, 209.—English oak, 209.—Elm, 210.

—Beech, 211.—English or Scotch fir and larch, 211.—Parliamentary

returns of the imports of foreign timber, 212.—Foreign timber, Memel, 212.—

Yellow pine, 213.—Timber of tropical climates, 213.—Teak, 214.—American

oak and rock elm, 214.—Means devised and adopted for preservation of

timber from decay, 215.—Kyan's solution of corrosive sublimate, 216.—

Margary's solution of acetate, or sulphate, of copper, 216.—Burnett's

patent for impregnating wood with chloride of zinc, 217.—Payne's process, by using two solutions which de-

compose each other, 217.—Bethell's patent for creosoting, 218.—Works at

Heybridge for creosoting sleepers for the Eastern Counties railway, 218.—

Creosote used either under pressure, or in open tanks, 219.—Description of

works at Rotherhithe for creosoting timber, 220.—Methods for ascertaining

the efficiency of the process, 221.—Appendix : patents for preserving animal

and vegetable substances, including timber, 222.—Ditto, experiments

in creosoting timber, 222.

Discussion.—Bethell, J., 223, 234.—Bidder, G. P., 241.—Boutigny, T. H.,

239.—Brunel, I. K., 233.—Burt, H. P., 223.—Cooper, J. T., 230.—Davison, R.,

235.—Errington, J. E., 241.—Hawshaw, J., 229.—Jackson, Lieut., 230,

240.—Moorsom, Capt. W. S., 231.—Rendel, J. M., 233, 242.—Vignoles, C.,

234.—Walker, J., 232.

Strength of, Captain Fowke's experiments as to, (Dunn, T.), xvi. 304.

Teak, resists attack of worm and white ant, but liable to injury from barnacles, i. (1840) 69.

TIMBER.

'Teredo navalis,' action of, on several kinds of timber (Cooper, J.), i. (1840) 69.

— "On the effects of the worm on Kyanized timber exposed to the action of sea water, and on the use of green-heart timber from Demerara, in the same situations." By J. B. Hartley, i. (1840) 84.—On metallic protectors for timber, 85.

— "Remarks on the ravages of the worm (*Teredo navalis*) in timber." By R. Davison, ii. (1842) 90.

—, specimens of timber affected by the (Redman, J. B.), iv. 77.—Existence of the '*Teredo navalis*,' in fresh water (Rendel, J. M.), vi. 54; (Curtis, J. G. C.), 54.—Attacks of, in brackish water (Redman, J. B.), 55.—Influence of the temperature of the water upon the action of the worm (Ayrton, F.), 55.

Tropical, quality of the, in the lower region of the tropics (Hopkins, E.), xix. 256.

White cedar. "On a specimen of white cedar from Bathurst, New Brunswick." By Mr. Churchill, i. (1840) 44.

Discussion.—Brunel, I. K., 45.—Hawkins, J. I., 44.—Horne, J., 45.

Vide also MACHINERY, Conversion of wood by; PERMANENT WAY; PIERS, Gravesend, cast-iron; and PIERS, Southend.

Timber and chain-cable testing-machines, on, (Dunn, T.), xvi. 301.

Timber staging used in forming the embankments of the Eastern Counties railway, iii. 158.

TIMPERLEY, J. [Telford medal, i. (1838), 8; Walker premium, iv. 4.]

Bridges. "Account of the building of the 'Wellington' bridge, over the river Aire, at Leeds," iii. 104.

Steam boilers, explosion of one of the, of the Union Steam Packet, at Hull, i. (1838) 41.

Timber, Kyanizing, i. (1841) 91.

— "Description of the tanks for Kyanizing the timber for the permanent way of the Hull and Selby railway," ii. (1842) 80.

TRAVAIL MECANIQUE.

Tire of railway carriage wheels, machine for bending and setting, (Woods, J.), i. (1841) 99.

TOLER, J. M. [Election, xx. 586.]

TOLMÉ, J. H. [Election, xx. 586.]

Tomes' machine for dental carving, iv. 250.

TOWN, J. F. [Election, xvi. 308.]

Water supply at Newcastle-on-Tyne, and as to parallelism of the mains of water-works, xviii. 403.

Tonnage, on the measurement of ships for, and on the speed and other properties of ocean steamers (Henderson, Capt.), xiii. 1.

TOOLE, W. [Election, i. (1839) 66.]

Tools used in manufacture of Colt's revolvers, xi. 62.

TOPHAM, J. [Election, xix. 214.]

Steam navigation, &c. Results of the application of superheating apparatus in vessels belonging to the Inter-colonial Royal Mail Company, xix. 472.

Tower of St. Rombaut, at Mechlin, x. 242.

Towns, drainage of, *Vide* DRAINAGE OF TOWNS.

—, supply of water to, *Vide* WATER SUPPLY; and WATER-WORKS.

TOWNSEND, G. B. [Election, xix. 546.]

TOWNSEND, B. [Election, i. (1838) 46.]

TOWNSEND, G.

Levelling. "Description of an improved level and stand," i. (1841) 117.

TOWNSEND, R.

Bridges. "Description of the Ponte della Maddalena, over the river Serchio, near Lucca," ii. (1842) 60.

Traction of boats on canals, ii. (1843) 114, 115.

Traffic over London Bridge, amount of, xiii. 235.

Transverse strain, experiments for ascertaining the relative amount of compression and extension, at the upper and under surfaces of rectangular beams of cast and wrought iron and wood, when subjected to (Colthurst, J.), i. (1841) 118.

TRATHAN, J. J. [Election, xvii. 52.]

Travail mécanique, or labouring force, of a man and also of a horse, useful effect produced by, xi. 77.

TREADWELL.

- TREADWELL, Professor D. (U.S.)**
 Artillery. Extract from a Paper by him, "On the practicability of constructing cannon of large calibre" (Lancaster, C. W.), xix. 376.
- TREDWELL, Messrs.**
 Horse-power. Experience in the use of horses on contract works (Horne, J.), ii. (1843) 117.
- TREHILLAS, E. O.** [Election, ix. 232.]
- Trellis bridges.** *Vide* **BEAMS, Lattice;** and **BRIDGES.**
- TREMENEHERR, Major-General G. B.**
 [Election, i. (1838) 39; Telford medal, xviii. 174.]
 Blasting. "On some operations in blasting in the Jumna, and at Delhi," i. (1838) 37.
- Canals in India, evaporation of water from, xvii. 537.
- Public works in India. "On public works in the Bengal Presidency," xvii. 483.—Remarks, 537.
- Railways in India, xvii. 514.—Question of branch railways, in contradistinction to district roads, 537.
- Trenails, compressed, by Ransome and May's process,** ii. (1842) 73, 74, 77, 79.
 —Cross-cut saw used in the manufacture of, xvii. 24.—Description of the manufacture, 32.—Remarks, 42, *et seq.*
- , uncompressed, ii. (1842) 78, 79.
- Used in the sea walls of Arbroath harbour, ii. (1842) 147.
- Treussart's investigations on mortars and cements,** xvi. 427.
- TREVITHICK, R.**
 Hydraulic engine (Taylor, J.), ii. (1843) 144.
- Trevithick and Vivian's locomotive engine** noticed, v. 69.
- TRICKETT, J.** [Election, xii. 272.]
- TRIGER, M.**
 Coal. System pursued in opening a bed of coal, underlying a quicksand 65 feet thick, near the banks of the river Loire, in France (Hughes, J.), x. 361.
- Trinity House, experiments on the chimneys of lamps,** ii. (1843) 189.—Ditto on the Bude light, 189.—Ditto on the ventilation of lighthouses, 209.

TUNNELS.

- Trinity House standard water-mark, recorded on a stone at the Hermitage entrance of the London docks,** ii. (1843) 87.
- TRUBSHAW, J.** [Memoir, xiv. 142.]
 Bridges. Centering employed in the construction of Chester bridge, i. (1837) 35.
- TSCHEFFKINE, General.** [Election, xviii. 525.]
- Tubes and girders, on the relative proportions of the top, bottom, and middle webs of iron** (Heppel, J. M.), xv. 155.
Vide also **GIRDERS** and **TUBES.**
- Tubing of locomotive boilers** (Buck, G.), i. (1839) 32.
- Tubular beams.** *Vide* **BEAMS;** and **BRIDGES,** **TUBULAR GIRDER.**
- Tubular bridge, Britannia, across the Menai Straits,** xi. 152.
- , —, weight of, compared with Boyne lattice viaduct, xiv. 465, 476, 481, 488.
- , Victoria, over the river St. Lawrence, at Montreal, xiv. 38, 101, 478.
- Tubular girder bridges.** *Vide* **BRIDGES,** **TUBULAR GIRDER.**
- TUCKER, J.**
 Permanent way. System of 'trellis railway' invented by him (Newton, W. E.), vi. 77.
- Tugs used upon the river Severn, details of the,** xix. 533.
- TULLOCH, Colonel, R.A.**
 Artillery. Advantage of the small muzzle of the Armstrong gun, xix. 423.
- Tulrow bridge, account of the alterations to,** (Forth, C.), ii. (1842) 165.
- TULLY, J.** [Election, v. 340; resignation, x. 72.]
- TUNNELS.**
 Beechwood. "An account of the repairs done to the Beechwood tunnel, upon the London and Birmingham railway, September, 1840." By T. M. Smith, i. (1841) 142.—Mode of conducting the repairs, 142.—The materials employed, 143.—Drainage, 143.—Duration of the repairs, 143.
- Birmingham extension, of Birmingham and Oxford Junction railway, details of,** (Lane, C. B.), xi. 77.

TUNNELS.

- Bleachingley, brick-making at, (Simms, F. W.), ii. (1843) 145.
- Box, Great Western railway, expense of working, (Moorsom, Capt. W. S.), ii. (1843) 108.
- Casualties of tunnelling. "On the casualties of tunnelling, with examples." By W. M. Peniston, xiii. 475.
- Discussion.—Braithwaite, F., 477.—Errington, J. E., 477.—Peniston, W. M., 477, 478.—Simpson, J., 478.—Wood, N., 477.
- Cost and manner of executing, for railways and canals in the United Kingdom, as compared with those on the proposed route, by the Valley of the Atrato, for effecting a junction between the Atlantic and Pacific oceans (Gregory, C. H.), xv. 405.
- Expansion of the clay in the tunnels of the Manchester and Bolton railway (Hawkshaw, J.), iii. 152.—Ditto, in the Primrose Hill and Kilsby tunnels (Forster, F.), 153.—Ditto, in Box tunnel (Thomson, J. G.), 153.
- Great Western railway. "Description of the tunnels, situated between Bristol and Bath, on the Great Western railway, with the methods adopted for executing the works." By C. Nixon, ii. (1842) 138.—Mode of executing, with shafts and driftways, 138.—Driftways at the lower side recommended, 139.
- Discussion.—Buckland, Dr., 139.—Bull, W., 141.—Nixon, C., 139.—Sopwith, T., 141.
- Lindal. "On the construction and enlargement of the Lindal tunnel, on the Furness railway." By F. C. Stileman, xix. 229.—Circumstances under which the tunnel for a single line was constructed, 229.—Various modes proposed for executing the works, 220.—Rules adopted for working the traffic during the operations, 231.—Explanation of the manner in which the works of enlargement were carried out, 231.—Difficulties encountered and overcome, 233.—Number of men employed and time occupied in the execution of the

TURNBULL.

- several works, 235.—Total cost of the tunnel, 236.
- Discussion.—Bidder, G. P., 239.—Fowler, J., 238.—Hawkshaw, J., 238.—Knight, G., 238.—Stileman, F.C., 238 239.—Walker, J., 239.
- List of the most important ones used in inland navigation, and for railways (Rennie, Sir J.), v. 35, *et seq.*
- Liverpool and Manchester railway, new tunnel, stationary engines at, (Gran-J.), i. (1841) 146.
- Moseley, method of construction of, iii. 369, *et seq.*
- Netherton tunnel branch, of the Birmingham canal, description of the works on the, (Walker, J. B.), xix. 263.
- Vide also* CANALS, Birmingham, Netherton tunnel branch of.
- Saltwood, application of horse power to raising water at, (Simms, F. W.), ii. (1843) 112.—Strata through which it is driven, 112.
- Tavistock canal, without internal arching (Taylor, J.), iii. 151.
- Thames. *Vide* THAMES TUNNEL.
- Ventilation of. "On the ventilation of tunnels." By W. West, i. (1838) 32.
- TURBINES.
- "Remarks on machines recipient of water power; more particularly the turbine of Fourneyron." By Prof. Gordon ii. (1842) 92.—Its mechanical action, and advantages, 94.—Comparison of the theory and practice of its construction, 94.—Experiments upon the efficiency of, 95.—Expenditure of water, 95.—Proposed by M. Arago for supplying Paris with water, 96.
- Discussion.—Farey, J., 102.—Rennie, G., 100.—Taylor, J., 96, 101.
- Introduction of, (Rennie, Sir J.), v. 53.—Recent improvements in, (Fairbairn, W.), viii. 59, *et seq.*
- Vide also* WATER-WHEELS.
- TURNBULL, G. [Telford premium, vi. 2.]
- Coal-drops. "Account of the drops used for the shipment of coals at Middlesbrough-Tees, with a short description of the town and port of Middlesbrough," v. 248.

TURNER.

TURNER, —.

Roofs. Deterioration of roof at Central Gas Company's works arrested by a coating of tar, xiv. 268.

TURNER, J.

Holborn Hill. "Holborn Hill, and the plans for its improvement," ii. (1842) 69.

TURNER, R. [Election, x. 57; Telford medal, 65; resignation, xviii. 182.]

Exhibition in 1851, construction of the building for the, and description of designs of his own for that building, x. 166, 186.

Roofs. "Description of the iron roof over the railway station, Lime-street, Liverpool," ix. 204.—Remarks, 211.—Original proposal for covering this station, 211.—Mode of testing the construction, 212.

TURNER, T. [Election, i. (1838) 41; resignation, x. 72.]

TURNTABLE.

"Description of a turntable, 42 feet in diameter, in use on the Bristol and Exeter railway." By J. J. Macdonnell, x. 245.

Turntables, traversers, points and crossings, and moving platforms, use of, for railway stations, xvii. 462.

TYNEMOUTH LIGHTHOUSE.

TURTON, T. B. [Election, xvii. 52.]

TWEEDDALE, Marquis of.

Bricks, machine for making, (Farey, J.), ii. (1843) 147; (Bennett, J.), 148.

TYER, E. [Election, xx. 292.]

TYLER, Captain H. W., R.E. [Election, xii. 520.]

Railway-breaks, particularly Mr. Newall's and M. Guérin's, xvii. 170.

TYNDALL, Professor.

Electro-motive power. Disadvantage of employing zinc, in the production of mechanical force, in comparison with ordinary coal, xvi. 404.—Alteration of the force of the current by the motion of the apparatus, 405.—Equivalence between heat and mechanical force, 405.

Slate rocks. Conjecture of the late Sir H. De la Beche, of the influence of polar forces in the production of slaty cleavage, xv. 67.—Slate formation in North Wales, 67.

Tyne docks, at South Shields, on the; and on the mode adopted for shipping coals (Harrison, T. E.), xviii. 490.

Tynemouth lighthouse, Professor Faraday's system of ventilation applied to the lamps of, ii. (1843) 209.

U.

ULSTER CANAL.

Ulster canal, description of, (Casebourne, T.), ii. (1842) 52.

Ulverstone iron ore, Clay's process of making iron from, ii. (1843) 82.

Undercliff, in the Isle of Wight, on earth-falls at the, (Rickman, W.), i. (1840) 35.

UNDERWOOD, Colonel.

Screw piles, utility of, for erections in fine compact sand, such as that on the coast of Coromandel, vii. 145.

Unguents, their influence on friction, ii. (1843) 72, 73, 76, 77, 78, 79.

UPWARD, A. [Election, ii. (1843) 155.]

URE, Dr.

Deodorizora. Chemical preparations for neutralizing and destroying noxious effluvia, and counteracting putrescence, vii. 97.—Nitrate of lead process of M. Ledoyen, 98.—Chloride, or muriate of zinc, process of Sir W. Burnett, 98.—Peroxide of iron, and protoxide of manganese, 98.

Eremacansia, or product of slow combustion, ii. (1843) 170.

Gas-lighting. Sir Humphry Davy's investigations, vii. 99.

Iron, mode of analysis of, ii. (1843) 178.

URE.

—Suggestions of the cause of the durability of iron steamers, 179.—Corrosion of iron ships and railway bars, 179.

Light. "Experimental researches upon the cost of the light afforded by different lamps and candles," i. (1839) 75.

Liquida. Details of some experiments on the fluidity of liquids, i. (1839) 76.

Locomotive boilers. Action of priming in, caused by the presence of carbonate of soda in the water, and the addition of a small quantity of sulphuric acid suggested as a remedy, viii. 175.

Pipes, copper, deposit of a carbonaceous substance in, from brewer's wort, ii. (1843) 170.

Sewage. Researches into the composition of the excrement of animals, vii. 99.

Steam boilers, priming in, viii. 176.

Water supply. Alkalinity of the water a great annoyance to the London brewers, viii. 175.

URE, J. F. [Election, xviii. 525.]

Dredging, cost of, in the Clyde, x. 293.

V.

VABRE.

Vabre's clay pots and hollow bricks for roofs and floors, xiv. 523.

VALENTINE, J. S. [Election, vii. 326.]

Bridges. "Description of a timber bridge erected over the river Ouse, at Hilgay, on the line of the Lynn and Ely railway," ix. 149.

Masonry. Combination of ashlar and rubble in the same work, x. 240.

Permanent way, best form of rail for, xvi. 383.

Railways. "Description of the line and works of the railway from Lisbon to Santarem," xviii. 1.—Remarks, 20.—Cost and character of labour in Portugal, 20.—Complications and disputes which arose between the contractors and the Government with regard to the bridges, 21.—Materials used in that country, 22.—Use of long, oaken, taper keys, instead of compressed keys, for railways in hot climates, 424.

VAILLANCOT, —,
Railway, atmospheric, iii. 269.

Valve, sluice, Jennings', xii. 272.

—, variable expansion, or revolving slide, invented by Messrs. Siemens, v. 259.—Mode of regulating the closing of a shut-off steam valve, which is opened by the engine in the usual manner, 260.

Valves, pump, on the concussion of, (Armstrong, Sir W. G.), xii. 450.

—, —, *vide* PUMP VALVES.

VAN DEN BERGH, M.

Rivers and estuaries. Translation of his Paper on the improvement of the Moselle (Jackson, G. B. W.), vii. 226.

VANDERKISTE, W. [Election, iii. 342; resignation, xiv. 108.]

Machinery. "Description of the machinery for working the diving-bell, used for setting the masonry under water, at the extension of the pier at Kilrush, in the river Shannon," v. 245.

VARDON, R. [Election, vii. 326.]

VAUGHAN.

VARLEY, O.

Locks and keys. Somerford's lock, and on the combinations of which locks are capable, ix. 336.

Patents, advantages of cheap, x. 215.

VARLEY, O. F.

Electric telegraph. Use of the induced charge as a severe test of the perfection of the insulation in the original subterranean wires through London, xvi. 213.—Machine for overcoming this induced charge, 213.—Induction, and the speed of electricity through submarine wires, 214.—Instantaneous conduction of electricity, 214.

Telegraph cables, testing, xx. 50.—Insulating powers of different materials, 51.—Importance of ascertaining the nature of the bottom on which a cable is to rest, and of the necessity of applying some outer protecting coating, and as to Atlantic cable, 51.

VARLEY, S. A. [Election, xviii. 72; Council premium, 174.]

Bells. Restoration of cracked bells by tin soldering, xix. 229.

Telegraph cables. Relative merits of light and heavy cables, xvii. 329.—Light submarine telegraph between Varna and the Crimea, 329.—Importance of obtaining an efficient conductor, 330.—Difference in the conditions between a submarine circuit and a Leyden jar, 331.—Error in supposing that a large wire conducts more slowly than a small one, 331.

— "On the electrical qualifications requisite in long submarine telegraph cables," xvii. 368.

Varnishes for protecting iron, ii. (1843) 176.

Vassy cement, manufacture and application of, xvi. 428, *et seq.*

VAUGHAN, G. [Election, xx. 375.]

VAUGHAN, G. L. [Election, xx. 103.]

VAUGHAN.

- VAUGHAN, J. [Election, xi. 299.]
 Vauxhall water-works, valves of the pumps at, ii. (1843) 195.
 Veneers, circular saw for cutting, xvii. 22.
 —Method of cutting veneers in Russia and in France, 22.—Meadows' method of bending veneers, 36.
 Ventilating and warming (Horne, J.), i. (1837) 42, 44.
 — public buildings and apartments (Hood, C.), i. (1839) 72, 74.
 Ventilation of Marshall's flax mill at Leeds, ii. (1842) 142.—Of Smith's weaving shed, 144.—Principles of, v. 108; x. 46.
 — Dr. Payerne's apparatus for purifying the air in a diving bell, ii. (1843) 191.
 — of lighthouses, necessity for, ii. (1843) 188.—Experiments proving ditto, 189.
 — of mines, on the, (Richardson, J.), vi. 160.
 — of New Houses of Parliament, vi. 203.
 'Vernon' East Indiaman, details of some experiments on the application of auxiliary steam power to the, i. (1841) 66.
 Vessels, *Vide* BOATS; COLLIERIES; SHIPS AND STEAM VESSELS; and STEAM NAVIGATION.
 VETCH, Captain J., R.E. [Election, i. (1839) 51.]
 Bridges. "Description of a bridge built of blue lias limestone, across the Birmingham and Gloucester railway at Dunhamstead," i. (1841) 136.
 Cuttings and embankments. Constructions to retain the sides of deep cuttings, iii. 369.
 Drainage of towns. Extracts from Professor Gordon's description of Captain Vetch's plans for the sewerage of the metropolis, as proposed in 1850 (Harrison, J. T.), xiii. 74.—Remarks as to ditto (McClean, J. R.), 85.

VIADUCTS.

Arched timber. "On the arched timber viaducts on the Newcastle and North Shields railway, erected by Messrs. John and Benjamin Green, of Newcastle-upon-Tyne; and the further application of the system to skew and

VIADUCTS.

- other bridges, as well as to the roofs of railway stations and other large buildings." By B. Green, i. (1841) 88; v. 219.—First model of an arched timber viaduct, submitted to the Newcastle and Carlisle railway company, for crossing the river Tyne, above Scotswood, 221.—Ouse Burn viaduct, Newcastle and North Shields railway, 222.
 —Wellington ditto, 225.—Details of the cost, 226.—Viaduct across the South Esk at Dalkeith, and its cost, 227.—Ditto proposed for crossing the river Tyne at a high level, to connect the towns of Newcastle and Gateshead, 228.—Oblique bridge crossing the Shields road, at Walker, 229.—Roof of Shields station, 230.
 Discussion.—Cooper, —, i. (1841) 91.—Lowe, G., 91.—Macneill, Sir J., 91.—Rendel, J. M., 90.—Timperley, J., 91.—Vignoles, C., 90.
 Ariccia, across a valley intersecting the line of the Via Appia, xiv. 235.
 Birmingham extension, of Birmingham and Oxford Junction railway, principal dimensions of, and materials employed (Lane, C. B.), xi. 70.
 Boyne, on line of Dublin and Belfast Junction railway, description of, (Barton, J.), xiv. 452. *Vide* also BEAMS, IRON.
 Calder. "Description of the Calder viaduct, on the Whithaw and Colnecse railway, with the specifications, estimates, and a series of experiments to ascertain the deflection of two of the strutted beams." By Sir J. Macneill, ii. (1843) 189.—Built for a single line, with the power of widening it, 189.—Piers and abutments for, built hollow, 190.—Usual load passing over, 190.—Cost of construction, 190.—Experiments upon the deflection of trussed beams, 191.
 Chapple. "Description of the Chapple viaduct, upon the Colchester and Stour valley extension, of the Eastern Counties railway." By P. Bruff, ix. 287.—Original design for laminated timber arches abandoned, 288.—Dimensions and construction of the present via-

VIADUCTS.

- duct, 288.—Permanent way over it, 290.—Brick-making, 290.—Cost of the structure, 291.—Progress of the works, 291.
- Discussion.—Barlow, P. W., 294.—Bruff, P., 292, 293, 294.—Brunel, I. K., 292.—Cubitt, Sir W., 293.—Robertson, A. J., 293.—Vignoles, C., 293.
- Congleton, on the North Staffordshire railway, accident to, during its construction (Bidder, G. P.), x, 239.
- Dinting Vale. "Description of the Dinting Vale viaduct, on the line of the Sheffield and Manchester railway." By A. S. Jee, v, 216.—Details of the cost of construction, 218.
- Discussion.—Jee, A. S., 218.—Pasley, Lieut.-Gen. Sir C. W., 219.—Walker, J., 219.
- Hall Bottom, on the West Riding Union railway, (Hawkshaw, J.), x, 298.
- Knaresborough, over the river Nidd, failure of, (Cubitt, Sir W.), x, 238.
- Landore. "Description of the Landore viaduct, on the line of the South Wales railway." By L. E. Fletcher, xiv, 492.—Principal dimensions of work, 493.—Details of truss of 110 feet span, 493.—Ditto 64 feet span, 496.—Ditto 73 feet span, 497.—Ditto 42 feet span, 497.—Ditto 50 feet span, 497.—Means of affording rigidity to structure both longitudinally and transversely, 498.—Scaffolding, 499.—Strains on structure, 500.—Deflection of trusses, 501.—Cost of structure, 501.—Permanence of timber structures, 501.—Appendix, measurement and cost of structure, and cost per foot run of the various trusses, 503.
- Discussion.—Barlow, P. W., 505.—Fletcher, L. E., 504.—Simpson, J., 506.
- Leven and Kent. "Description of the iron viaducts erected across the tidal estuaries of the rivers Leven and Kent, in Morecambe bay, for the Ulverstone and Lancaster railway." By J. Brunlees, xvii, 442.—Sea-embankments across ditto, 442.—Superficial stratum of these estuaries, 442.—Experiments to test the bearing power of the sand,

VIADUCTS.

- and to determine the size and form of disc best adapted for a permanent foundation, 442.—Mode of sinking the piles, 443.—Details of the construction of the Leven viaduct, 445.—Dimensions and cost, 446.—Ditto of the Kent viaduct, 446.
- Discussion.—Brunlees, J., 448.—Hawkshaw, J., 448.—Locke, J., 448.
- Lockwood. "Description of the Lockwood viaduct, on the Huddersfield and Sheffield railway." By J. Hawkshaw, x, 296.—Peculiar style of the masonry, 296.—Principal dimensions, 297.—Materials employed, 297.
- Discussion.—Beardmore, N., 301.—Clegg, S., Jun., 300.—Cubitt, J., 300.—Fowler, J., 302.—Giles, A., 301.—Gregory, C. H., 301.—Hawkshaw, J., 300, 301.—May, C., 302.—Russell, J. S., 301.—Simpson, J., 302.
- Manchester. "Description of an iron viaduct erected at Manchester, on the joint station of the London and North Western, and the Manchester, Sheffield, and Lincolnshire railways." By A. S. Jee, xi, 224.—System of construction adopted, 224.—Store-street crossing, 225.—Stirling's toughened iron, 226.—Details of the quantities and cost of each part of structure, 226.—Appendix, showing result of tests applied to each girder, 227.
- Discussion.—Bidder, G. P., 234, 236.—Brunel, I. K., 237.—Fowler, J., 233.—Hawkshaw, J., 238.—Pole, W., 236.—Rendel, J. M., 240.—Russell, R., 234.—Russell, J. S., 233, 236, 238.—Simmons, Capt., 237.—Simpson, J., 234, 240.—Stirling, M., 238.
- Medlock, near Manchester, description of the, (Hawkshaw, J.), x, 299.
- Newry (Rendel, J. M.), xi, 152.
- Nora. "Description of the viaduct erected over the river Nora, near Thomastown, in the county of Kilkenny, to carry the Waterford and Kilkenny railway." By Capt. W. S. Moorsom, xi, 426.—Proposed alteration of authorised line abandoned, 427.—Delays arising from scrutiny of Board of Works in Ireland

VICAT.

- 427.—Letting of the contracts, 428.—Labour employed and progress of work, 428.—Stone and mortar employed in works, 429.—Details of masonry, 429.—Timber for arch, or beam, 430.—Details of lattice-beams, and mode of erecting, 430.—Settlement of the arch, or beam, 432.—Quantity of materials employed, 433.—Cost of works, 433.
- Discussion.—Bidder, G. P., 434.—Doynce, W. T., 434.
- Paddock, near Huddersfield (Hawkshaw, J.), xi. 13.
- Penistone, description of the, on the Huddersfield and Sheffield railway (Hawkshaw, J.), x. 299.
- Poiney, on the line of the Madras railway; description of the method of building bridges upon brick wells, in sandy foundations, illustrated by the, (Bruce, G. B.), xvi. 449. *Vide* also BRIDGES, FOUNDATIONS OF.
- Railway, remarks as to cost of, xiv. 209, 504.
- Royal Border bridge, over the river Tweed, on the York, Newcastle, and Berwick railway (Bruce, G. B.), x. 219. *Vide* also BRIDGES, STONE, Royal Border.
- Salford. "Description of a cast-iron viaduct, or colonnade, constructed at Salford." By J. Hawkshaw, xi. 241.—Dimensions and cost, 242.—Experiments on strength of girders, 242.
- Vide* also AQUEDUCTS; BEAMS; BRIDGES; BRIDGES, IRON; BRIDGES, LATTICE; BRIDGES, STONE; BRIDGES, TUBULAR GIRDERS; COFFER DAMS; FOUNDATIONS; GIRDERS; and IRON.
- VICAT, M.
- Cement. His opinion of Portland cement (White, G. F.), xi. 484.—His researches as to the theory of the action of limes with siliceous materials (Rennie, G.), xvi. 427.
- Victoria (Australia), engineering works in the colony of, (Annual Report), xviii. 168.
- Victoria bridge across the river Wear, on the line of the Durham junction railway (Bremner, D.), ii. (1843) 97.

VIGNOLES.

- Victoria (London) docks, description of the entrance, entrance-lock, and jetty walls of the; with a detailed account of the wrought-iron gates and caisson, and remarks upon the form adopted in their construction (Kingsbury, W. J.), xviii. 445. *Vide* also DOCKS.
- Victoria tubular bridge over the river St. Lawrence, at Montreal, xiv. 38, 101, 478.
- VIGERS, —.
- Machinery for the conversion of timber, and particularly as to planing-machines, xvii. 48.—Mode of counteracting the jar with iron frames, 49.—Best speed for circular saws, 49.—Blanchard's timber-bending machine, 49.
- VIGNOLES, C.
- Blasting under water. Discharge of gunpowder, xv. 339.
- Breakwaters, forms of, ii. (1842) 127.
- Bridges. Floating bridge over the Hamoaze, from Devonport to Torpoint, i. (1838) 23.—Model of a timber bridge, 90.—Adaptation of suspension bridges to railways, 128.—Victoria bridge, ii. (1843) 98.—Suspension bridges, particularly that at Kieff, in Russia, and as to the proportions between the pin, head, and body of link, viii. 280.—Application of the principle of the floating bridges, introduced by the late Mr. Rendel, for crossing the Forth and Tay ferries, xx. 387.
- Canal incline-planes, xiii. 211.
- Diving dress, importance of the, for engineering purposes, xv. 339.
- Drainage of towns. Amount of pumping to be performed in the drainage of the district south of the Thames, and the necessity for providing for an excessive rainfall, xiii. 100.
- Engines, friction of, ii. (1843) 72, 77.
- Exhibition in 1851, credit due to Mr. Paxton for the design for the building for the, x. 165.
- Girders. Construction and use of cast-iron girders, with wrought-iron truss-rods, vi. 220.—Failure of the girder in Messrs. Gray's mill at Manchester, 223.

VIGNOLES.

- Principles of the Warren girder, xii. 609.
- Gold. Theory that gold-bearing, or other stratified rocks are disposed in a vertical direction, xv. 58.
- Gunpowder, Dr. Hutton's experiments for ascertaining the force of, xix. 360.
- Horse power, i. (1841) 70.
- Iron, manufacture of, ii. (1843) 131; iii. 245.
- Lighthouses, Maplin Sand and Port Fleetwood, ii. (1842) 152; vii. 156.
- Lock-gates, iii. 256.
- Locomotive engines, relative advantages of railway companies, or private firms, manufacturing, xi. 468.
- Masonry. Distinction to be drawn between concrete, or *béton*, and rubble work, and use of *béton* in Russia, xvi. 438.
- Metal, sectional area of, must always be proportioned to the duty to be performed, xiii. 470.
- Naval construction, &c. Iron water-tight bulkheads in ships, ii. (1843) 179.—Coincidence between the strength of iron steam vessels and the wrought-iron tube proposed by Mr. R. Stephenson for traversing the Menai Straits, iv. 306.
- Permanent way. Railway chairs and their fastenings, i. (1841) 86.—Position of the neutral axis in railway bars, 121.—Permanent way of the Dalkey railway, and on the first introduction of the T-shaped rail, v. 245.—Necessity for elasticity in permanent way, xx. 282.
- Pier at Southport, Lancashire, and plan of sinking the piles, xx. 298.
- Piles, driving, iii. 201.
- Railway, atmospheric, iv. 272, 278.
- Railway breaks, xix. 518.
- Railway inclines, mode of working, particularly the Semmering and Giovi, xv. 368.
- Railways, legislative interference in the construction of, ix. 244.—Friction, or adhesion on a railway, xix. 521.
- Rivers and estuaries. Effect of proposed chain of locks at London bridge would be to convert the upper portion of the

VIVIAN AND TREVITHICK.

- Thames at London, from a river ebbing and flowing with the tide, into a river flowing only in one direction, with a small uniform current, xv. 210.—Sanitary condition of the Thames, 210.—Effect upon the atmosphere of the rise and fall of the tide in the Thames, 230.
- Roads. State of the macadamized roads of London compared with those of Paris, xii. 237.
- Roofs, Collar-roof at East Horsley Park, and principle of built-up and bent-timber beams, viii. 286.
- Ships and steam vessels. Measurement of ships for tonnage, xiii. 62.—Plan for taking vessels into a small dock, by the side of the Vistula, at Warsaw, 209.
- Timber. Durability of dry yellow pine, and process of creosoting, xii. 234.
- Tunnel, Woodhead, on the Manchester and Sheffield railway, xix. 278.
- Viaducts, general cost of, ix. 293.
- Water, temperature of, in deep wells ii. (1843) 143.
- Wells, ii. (1843) 58, 143.
- VIGNOLES, H. [Election, viii. 164.]
- VIGORS, T. M. [Election, xiv. 374.]
- VIGORS, —.
- Rivers and estuaries. Proposition to form a new channel for the river Avon (South Wales) by the force of the land floods, ii. (1842) 188.
- VINCENT, —.
- Junction of the Atlantic and Pacific oceans, by the valley of the Atrato, in Central America, xv. 409.
- VINBAQ, M.
- Decimal coinage, &c. His visit to this country, during the time of the Exhibition of 1851, to induce the British authorities to adopt the French metrical system of weights, measures, and coins (Manby, C.), xiii. 336.
- VINT, H. [Election, i. (1838) 5; memoir, xii. 167.]
- VITRUVIUS, —.
- Harbours. Quotation from, as to harbours and other buildings in water (Rennie, G.), xvi. 424.
- Vivian and Trevithick's locomotive engine, v. 69.

VOLUTE SPRINGS.

Volute springs, application of, to the safety-valves of locomotive boilers (Baillie, J.), xv. 28.—Their application as bearing, buffer, and traction springs to locomotive engines and tenders, waggons, trucks, and carriages, and as auxiliary springs for common road carts and waggons, 37, *et seq.*

Vulcanized india-rubber, specimen of, iv. 58.—Observations upon the manufacture, cost, and application of, 58.—Details of some experiments on its resistance to impact, 59.—Asserted destruction of, when immersed in water for a long period, xiii. 432.

VULLIAMY, B.

Wells. The first to introduce the anger, or miser, for sinking (Farey, J.), ii. (1843) 59.

VULLIAMY, B. L. [Election, i. (1838) 21; Auditor, ii. (1842) 51; premium, v. 2; memoir, xiv. 155.]

VULLIAMY.

Bequest of (Annual Report), xiv. 107.

Chronometers, &c. Performance of watches affected by the quality of the oil applied to them, vi. 246.—General construction of, 247. — Pendulum springs for, 247.—Works of a clock made by Tompion, 495.

Gas. Injurious effects of gas upon gun metal, as shown by the corrosion of two pair of communication joints belonging to the clock at the General Post Office, St. Martin's-le-Grand, v. 360.

Railway clocks. "On the construction and regulation of clocks for railway stations," iv. 63.—Remarks, 72, 73.—Solar time, and on equation clocks, 76.

Ships and steam vessels. Quotation from Lord Anson, on the state of navigation in the year 1740, vi. 248.

VULLIAMY, G. J. [Election, iv. 186; resignation, xvii. 85.]

W.

WADHAM.

- WADHAM, E. [Election, xiii. 64.]
 Waggon, railway, for the conveyance of merchandise, construction of, xi. 454.
 Waldersea drainage, valves used in the pumps at, ii. (1843) 195, 199.
 WALKER, C. R. [Election, xix. 461.]
 WALKER, C. V.
 Electric telegraph. Assumed liability of telegraph posts to accidents, and comparative advantages of suspended and underground systems of wires, xi. 377.
 WALKER, Honourable R. J., (U.S.).
 Civil engineering, importance of profession of, xi. 64.
 Fire-arms, repeating, xi. 65.
 WALKER, J. [President, i. (1837) 15; (1838) 20; (1839) 27; (1840) 36; (1841) 52; ii. (1842) 51; (1843) 67; iii. 66.]
 Addresses, as President, to annual general meetings, i. (1839) 15; (1840) 15; (1841) 23; ii. (1842) 21; (1843) 22; iii. 25.—On vacating the chair, iv. 20.
 Air engine, Stirling's, iv. 356.
 Arches. Propriety of using cement for brick arches, and hydraulic lime for those of stone, v. 219.
 Axles, solid and hollow, ii. (1843) 94.
 Boilers, cause of the elevation of, from their seats, i. (1841) 114.
 Breakwaters. Effect of the storm of February, 1848, on Plymouth, i. (1841) 115.—Plymouth, vii. 399.
 Brick-raising machine, Journet's, iii. 222.
 Bricks, injury arising from the use of carbonate of lime in the manufacture of, xvi. 444.
 Bridges. Mr. Rendel's Paper "On the Montrose suspension bridge," i. (1841) 128.—Victoria bridge, the materials employed, and the merit due to the engineer and contractors, ii. (1843) 98, 99.—Wrought-iron lattice bridge on the Dublin and Drogheda railway, iii. 64.—Model showing the construc-

WALKER.

- tion of the Ouse bridge, on the Hull and Selby railway, iv. 90.—His report to Sir J. Graham on the causes of the failure of the Yarmouth suspension bridge, 296.—Particulars relating to ditto, 297.—Specification and drawings for ditto, 297.—Dimensions of various parts, 298.—Reason for making additions to the width of the bridge after construction, 298.—The foundations, 299.—Position of the load at the time the accident occurred, 299.—Examination of the parts that failed, 299.—Strength of the bridge compared with the load it had to sustain at the time of the accident, 300.—Results of the investigation, 301.—Particulars of the weight of the bridge before and after the additions were made to it, 302.—Athlone bridge, viii. 303.—Effects of impact on a large structure built of elastic materials, ix. 274.
 Buoys, beacons, sea-lights, &c. Beacon on the Goodwin Sands, vii. 136.
 Caisson, aliding, at Keyham dockyard, xiii. 458.
 Canals. Great Western canal lifts, i. (1838) 28.—Comparison between the North Holland canal and the Caledonian canal, vi. 111.—Lock at the Inverness end of the Caledonian canal, 111.
 Cement. Quality of Portland cement not always uniform, xvi. 439.—Causes of the expansion of Portland cement, 444.
 Civil engineering, i. (1839) 16.—Connection between geology and civil engineering, i. (1840) 86.
 Coasts, &c. Accumulation of shingle, and deposition of silt at Dover, vii. 400.
 Cofferdams, construction of, viii. 303.
 Cranes. Moveable jib-crane used at Granton pier, iv. 345.
 Datum line, general, for tidal reference, throughout England, v. 311, 313.

WALKER.

- Docks. Proposed south docks at Sunderland, vi. 281.—Dock entrances, vii. 175, 179.—New docks at Sunderland, viii. 197.
- Drainage of land, iv. 203.—Comparison of the drainage of Holland with that of the Bedford Level, vi. 110.
- Drainage and sewerage of the metropolis, vii. 104.—Size of sewers, 106.
- Fluids, resistance to bodies moving in, experiments tried in the East India dock, and the machinery employed, for determining the relation between the velocity and the, v. 277.
- Foundations. Cast-iron cylinders used at the Point of Ayr for foundation for a lighthouse, ii. (1842) 65.—Method of forming foundations of bridge over the river Nene, at Peterborough, and at Rochester, x. 866, 867.
- Gas, purifying coal, iii. 308.
- Harbours. Survey of Plymouth Sound, v. 311.
- Harbours of refuge, indifference of mercantile shipowners to the formation of, vii. 399.
- Horse-power, ii. (1843) 115.
- Huddart, Captain, portrait of, presented by, i. (1841) 13.—Memoir of, ii. (1842) 58.
- Iron, preservation of, against the action of sea-water, ii. (1843) 169.—Value of R. Mallet's Paper on the corrosion of iron, &c., 180.—Chemical changes in cast iron, iii. 88.
- Lighthouses, revolving lenses in, i. (1840) 25.—Effect of the storm in the year 1840 on the Edystone lighthouse, i. (1841) 115.—Maplin Sand lighthouse, ii. (1842) 151, 152.—Point of Ayr lighthouse, 154.—Construction of lighthouses, and especially those upon the Bishop Rock and at the Point of Ayr, vii. 137, 143.—Maplin Sand lighthouse, 155, 156.—Gun-metal lantern for Point of Ayr lighthouse, 158.—Small's lighthouse, ix. 189.—Failure of the Bishop Rock lighthouse, 192, 194.—Maplin and the Point of Ayr lighthouses, 193.
- Lock-gates, iron, iii. 255, 256.

WALKER.

- Locomotive engines, American, i. (1840) 49.
- Masonry. Mode of laying the stones in hydraulic constructions, v. 248.—Use of washed gravel, without lime, for the backing of quay walls, xvi. 439.—Application of cement concrete at Dover and at Alderney, 439.
- Motive power, differences between the application of steam and water as a, ix. 385.
- Naval construction, &c. Bulkheads in ships, ii. (1843) 179.
- Permanent way. Trenails used on the Hull and Selby railway, ii. (1842) 78, 79.—Loosening of railway keys, iv. 57.
- Portrait, iv. 5.
- Railway, atmospheric, iii. 85; iv. 289.
- Railway cuttings and embankments, iii. 170.
- Railway, London and Blackwall, v. 158.
- Reservoirs, impounding, applied to all large towns, vii. 286.
- Rivers and estuaries. Rise and fall of the tide in the Thames, i. (1839) 67.—The Severn and its capabilities for improvement as a navigation, v. 309.—Improvements in the Clyde, and effects produced, 316.—Mode of testing the deposits in the river Wear, vi. 282.
- Roofs. Collar-roof at East Horsley Park, viii. 286.
- Scaffolding, iii. 211.
- Screw moorings, and the use of screw piles for the foundations of lighthouses, vii. 186.—Holding power of screw moorings, 143.
- Screw propellers, iii. 85.
- Screw threads, uniform, i. (1841) 160.
- Sea-defences, forms of construction of, with observations on the Plymouth breakwater, and on the rising of seas against nearly vertical walls, vii. 202.—Relative merits of vertical, or sloping walls and their comparative expense, 401, 415.—Groynes on the South Rocks at Sunderland, viii. 197.
- Steam engines. Experiments on the working of Cornish engines, i. (1838) 12.
- Steam navigation, &c. Proportion of the

WALKER.

- power of the engines to the tonnage in steam vessels, i. (1841) 70.
- Stone, artificial, manufacture of, with a silica base, vii. 67.—Its use for building purposes, 69.
- Timber, specific gravity of Kyanized, ii. (1842) 83.—Preservation of timber, xii. 232.
- Tunnels. Works for the construction and enlargement of the Lindal tunnel, on the Furness railway, xix. 239.
- Uniform time. General adoption of Greenwich mean time throughout the country, iv. 72, 76.
- Water supply. Rain-gauge experiments, vii. 281.
- Waves, action of, at the Plymouth break-water, ii. (1842) 128.
- Walker premiums, establishment of, i. (1841) 27.—Annual donation of the interest of £1000, 27.—Cessation in the distribution of, and the cause, v. 2.
- WALKER, J. R. [Election, xviii. 406; Council premium, xx. 122.]
- Canals. "Description of the works on the Netherton tunnel branch of the Birmingham canal," xix. 263.—Remarks, 277.—Strata passed through in sinking the shafts and in driving the tunnel, 277.—Cost and mode of execution of the works, 281.
- WALLACE, J. [Election, ii. (1842) 56; resignation, xiii. 134.]
- Iron, composition of, in smelting, ii. (1842) 61.
- WALLACE, Professor. [Memoir, iii. 10.]
- Pentagraph and eidograph, i. (1839) 65.
- WALLICH, Dr.
- Telegraph cables, surveys hitherto made of the bottom of the sea not sufficiently complete for the purpose of safely submerging, xx. 75.—Different routes for an Atlantic telegraph, particularly as to the proposed line from England to Labrador, 76.
- Walls, brick, notice of a wall which had twice fallen, on account of the non-adhesion of the mortar to the bricks, ii. (1843) 152.
- , retaining, on the formation of em-

WARREN.

- bankments and the filling in behind (Hartley, J. B.), i. (1841) 143.
- Walls, brick, for the sides of railway cuttings, iii. 145. *et seq.* Vide also RAILWAY CUTTINGS AND EMBANKMENTS.
- , rubble, weight supported by, ii. (1842) 177.
- , sea. Vide BREAKWATERS; COASTS; HARBOURS; HARBOURS OF REFUGE; PIERES; and SEA DEFENCES.
- WARBURTON, H.
- River Thames. Nature of the strata in the bed of the Thames, on the site of the Tunnel, and nature and relative positions of the London and plastic clays, ix. 21.
- WARD, —.
- Bridges. Proposed the use of the cast-iron caissons for the bridge over the Avon, near Tewkesbury (Moorsom, Capt. W. S.), iii. 61.
- WARD, F. O.
- Water supply. Chemical properties of the water of the Trafalgar Square well, and on the presence of bromine in tidal wells, ix. 178.
- WARD, J. [Election, vii. 326.]
- WARD, R. J. [Election, xix. 263.]
- WARDELL, W. W. [Election, xvii. 195.]
- WARING, C. [Election, x. 293.]
- WARING, C. H. [Election, x. 57.]
- WARING, H. [Election, xiii. 64.]
- WARMING AND VENTILATING.
- "On warming and ventilating." By J. Horne, i. (1837) 42.
- Discussion.—Ottam, E., 43.—Hawkins, J. I., 43.—Oldham, J., 43, 44.—Palmer, G. H., 43.
- Joyce's heating apparatus, i. (1838) 11.
- "On warming and ventilating public buildings and apartments, with an account of the methods which have been most successfully employed for ensuring a healthy state of the atmosphere." By O. Hood, i. (1839) 72.
- Elementary principles of, (Rennie, Sir J.), v. 108.
- WARNER, J. [Election, xii. 109.]
- WARREN, F. [Election, v. 478.]
- WARREN, J. N. [Election, viii. 164.]
- Bridge, insistent pontoon, at the Dublin

WARREN.

- terminus of the Midland Great Western railway of Ireland, ix. 352.
- Permanent way. Orescoted sleepers on the Northampton and Peterborough railway, ix. 52.
- Timber. Payne's process for impregnating timber with two chemical substances, ix. 52, 57.
- Warren's girder bridges for railways in India, xi. 14.—Newark Dyke bridge, on Great Northern railway, xii. 601.—Distribution of the material in beams constructed on this principle, xiv. 443, *et seq.* *Vide also* BEAMS; and GIRDERS.
- WARRNER, H. [Election, ii. (1842) 138.]
- WASHINGTON, Captain J., R.N. [Election, iv. 186.]
- Buoys, beacons, sea-lights, &c. Comparative merits and expense of floating and fixed lights, vii. 139.—Buoys and sea-lights, and manner of mooring, xv. 10.
- Coasts, &c. His report on the memorial of the mayor and corporation of the borough of Harwich (Redman, J. B.), xi. 195.
- Lighthouses, screw-pile, on the Maplin Sand, at Fleetwood-on-Wyre, and at Belfast, vii. 139.—Silvered porcelain reflectors for lights, xv. 24.
- Screw-moorings in the Clyde, the Humber, and the Tyne, vii. 139.
- Waste-board at Naburn lock, on the river Ouse (Renton, H.), i. (1840) 26.
- Watches; on the laws of isochronism of the balance-spring, as connected with the higher order of adjustments of watches and chronometers (Frodsham, O.), vi. 224.
- Water, on the velocity of the, in Belfast harbour (Bald, W.), i. (1837) 87.
- , account of boring for, through granite (Holland, F.), i. (1839) 44.
- , on the action of air and, upon iron and steel (Mallet, R.), ii. (1843) 171.
- , quantity of, produced by the combustion of oil and coal gas, ii. (1843) 185.
- , the means of rendering large supplies of, available in cases of fires (Braidwood, J.), iii. 309.
- for locomotive engines, and its chemical analysis (West, W.), v. 182.

WATER.

- Water, necessity for a uniformly good supply, and means of purifying, xvi. 12.
- , —, viii. 171, *et seq.* *Vide also* RAILWAY STATIONS, Camden.
- , process for softening chalk, Professor Clark's, xiv. 59.
- , friction of vessels passing through, xv. 302; xvi. 329, 337, 361, *et seq.* *Vide also* STEAM NAVIGATION.
- , resistance to bodies moving in, xvi. 329. *Vide also* STEAM NAVIGATION.
- , decomposition of, in the ordinary process of making water gas, i. (1838) 46.—Gases produced by the, xvi. 419.
- WATER, DISCHARGE OF.
- Overfalls or weirs. "Results of a series of experiments on the discharge of water by overfalls, or weirs." By T. E. Blackwell, x. 331.—Great want of facts in this branch of hydrodynamics, 331.—Particulars of the first set of two hundred and forty-three experiments made on the Kennet and Avon canal in July 1850, 331, 332.—Ditto of the second set of seventy experiments made at Chew Magna, in 1850, 331, 334.—Review of experiments by English and Continental observers, on the passage of water over weirs, 332.—By Du Buat, in 1779, 332.—By Poncelet and Lesbros, in 1827–8, 332.—By D'Aubuisson and Castel, in 1834, 332.—By Smeaton and Brindley, 332.—Explanation of tables containing the results of the experiments, 335.—Tables of experiments on overfalls, Kennet and Avon canal, 1850; I. Overfall, thin plate, 3 feet long, 337.—II. Ditto, 10 feet long, 337.—III. Ditto, plank, 2 inches wide, 2 feet long, 338.—IV. Ditto, 6 feet long, 339.—V. Ditto, 10 feet long, 340.—VI. Ditto, fitted with wing boards, converging at an angle of 64°, 341.—VII. Ditto, with crest, 3 feet wide, sloping 1 in 12, 3 feet long, 341.—VIII. Ditto, sloping 1 in 18, 3 feet long, 341.—IX. Ditto, 10 feet long, 3 feet wide, sloping 1 in 18, 342.—X. Ditto, 3 feet wide, level, and 3 feet long, 342.—XI. Ditto, and 6 feet long, 343.—XII. Ditto, and 10 feet long,

WATER.

343.—XIII. Overfall bar, 2 inches wide, 10 feet long, 344.—General results of the experiments, 345.—Appendix, table showing the variation of the co-efficients, for different species of overfall, 348.—Ditto, for different heads of water, 348.

Discussion.—Ballard, S., 352.—Blackwell, T. E., 350.—Cawley, C. E., 352.—Hawthshaw, J., 351.—Russell, J. S., 350.—Simpson, J., 350.

Pipe drains and brick sewers, quantity of water discharged by, xii. 49, *et seq.*; xiii. 115, *et seq.*; xiv. 289, *et seq.* *Vide also DRAINAGE OF TOWNS.*

Tables showing the full theoretical discharge of water due to the observed heads at the new dock works at Grimsby (Beardmore, N.), ix. 8.

Water, evaporation of, in steam boilers (Parkes, J.), i. (1838) 17.

WATER, FLOW OF.

Experiments, published results of, made under the direction of Board of Health, on the flow of water through a pipe at Alnwick (Bidder, G. P.), xiii. 115, *et seq.*—Experiments of M. Couplet on a pipe 18 inches in diameter (Hawksley, T.), 117. *Vide also DRAINAGE OF TOWNS.*

Gaugings. "On a mode of computation, whereby flood water may be excluded from a set of gaugings taken at regular intervals, and therefore including floods." By J. Leslie, x. 327.—Time when stream is in a state proper for gauging, 327.—Mode of computing the quantity of water, exclusive of floods, 327.—Table (I.) of gaugings taken at regular intervals for three summer months, adjusted so as to give the result exclusive of flood water, 329.—Table (II.) of gaugings taken once a week for eight months, during two years, 330.

Discussion.—Cawley, C. E., 331.—Simpson, J., 331.

Pipes. "Experiments on the flow of water through pipes of different lengths." By W. A. Provis, i. (1838) 48.

—, conduits, and orifices. "Observa-

WATER-METERS.

tions on the flow of water through pipes, conduits, and orifices." By J. Leslie, xiv. 273.—Formula of Dr. Thomas Young, 275.—Results of experiments with simple orifices and short tubes, 279.—Observations on the pipes of the Edinburgh water company, 282.—Ditto on the conduit of the Dundee water-works, 283.—Calculated discharges according to Leslie's hydrodynamics, 283.—Observations on sluicing from dock gates, 284.—Ditto on weirs or notch-boards, 285.

Discussion.—Bazalgette, J. W., 290, 307, —Beardmore, N., 299, 308.—Bidder, G. P., 288, 311, 314.—Hawksley, T., 290, 291, 304, 306, 309, 314.—Haywood, W., 289, 310.—McClellan, J. B., 310.—Phipps, G. H., 301, 304, 306.—Rawlinson, R., 304, 313, 314.—Russell, J. S., 314.—Simpson, J., 316.—Stophenson, R., 290.

Rivers, flow of water in, when approaching weirs, v. 346, *et seq.* *Vide also RIVER SEVERN.*

Water, spheroidal state of, at high temperatures, xi. 392, 398, *et seq.*; xv. 288, *et seq.*

—, temperature of, in wells and mines, ii. (1843) 141, *et seq.*

Water ballast, xiv. 329. *Vide also COLLIERIES, Steam and sailing.*

Water camels for lifting vessels over sand-banks and shoals, vi. 82.

Water companies, extension of works of metropolitan, xiv. 65, 100.

Water mains, joints of, xiv. 40, 41.

WATER-METERS.

"A model and drawing of a lock-meter, used in Lombardy for measuring water for irrigation." By B. Albano, ii. (1843) 200.—Standard for the emission of water to the irrigating channels, 200.

"Description of a water-meter." By P. Carmichael, iii. 68.

"On water-meters." By D. Chadwick, xiii. 421.—Want of a good high-pressure water-meter, 421.—Extract from report of jury of Great Exhibition on, 421.—List of, for which patents have

WATER-MILLS.

been obtained, from the year 1824, 422.

—High-pressure meter on the diaphragm principle, by Mr. Parkinson, 425.—Ditto on the water-wheel, turbine, spiral fan, drum, &c. principles, 425.—Mr. Taylor's meter, 425.—Mr. Siemens' meter, 426.—Messrs. Siemens and Adamson's meter, 426.—Capt. Ericsson's rotary fluid meter, 426.—Ditto reciprocating fluid meter, 427.—High-pressure meters on the piston and cylinder principle, 426.—Messrs. Hanson and Chadwick's meter, 427.

Discussion.—Bateman, J. F., 432.—Brockedon, W., 432.—Brunel, I. K., 430.—Chadwick, D., 436.—Cooper, J. T., 434.—Lilley, —, 435.—Russell, J. S., 434.—Siemens, O. W., 431.—Webster, T., 435.

“On recent improvements in water-meters.” By T. T. Jopling, xvi. 46.—Extract from Paper by Mr. O. W. Siemens, as to the merits and defects of piston and bucket meters, 46.—Description of a new piston meter, 47.—Manner of transferring the reciprocating motion of the pistons to the index, 48.—Advantages of enclosing the measuring cylinders in a water-tight case, 49.—Results of the working of the new meters at the Sunderland and South Shields water-works, 49.—Application of the principle to a 2-inch meter, for measuring hot as well as cold water, for steam-boiler purposes, 50.

Discussion.—Chadwick, D., 64.—Greaves, C., 56.—Hawksley, T., 60, 64.—Jopling, T. T., 51, 59.—Kennedy, T., 55.—Locke, J., 64.—Rawlinson, R., 63.—Siemens, O. W., 51, 63.—Simpson, J., 59.

Water mills, notice of Smeaton's experiments and reports on, v. 21.

— pipes between Twickenham and Richmond, crossing the river Thames; description of coffer-dams used in laying the lines of, (Munday, G. J.), xiv. 32.

— power, remarks on machines recipient of, more particularly the turbine of

WATER SUPPLY.

Fourneyron (Gordon, Prof.), ii. (1842) 92.

Water-pressure engine at Freyberg, Saxony (Baker, W. L.), ii. (1843) 143.

— at Illaang, Bavaria, (Baker, W. L.), ii. (1842) 55.

— rights, law of, both as to the ownership of underground water, and of water flowing over the surface, remarks in the course of the discussion on the river Wandle, xx. 250.

WATER SUPPLY,

Artesian wells. “On the supply of water from artesian wells.” By R. W. Mylne, i. (1839) 59.—Particulars relative to the sinking of the well in the Hampstead road, 60.—Notice of a report made by Mr. J. Simpson on ditto, 62.

Discussion.—Brunel, Sir M. L., 62.—Simpson, J., 62.

Bombay. “Description of the works, recently executed, for the water supply of Bombay, in the East Indies.” By H. Conybeare, xvii. 555.—Rapid increase in the population, and advantages of the geographical position, of Bombay, 555.—Hitherto cut off from the productive districts of the interior, by an abrupt mountain chain, which the railways, now in progress, will remedy in future, 555.—Deficiency in the existing water supply, and badness of its quality, 555.—Lord Elphinstone's remarks on the occasion of turning the first sod of the new works, 556.—Geological and hydrographical conditions of the island of Bombay, 556.—Projects for increasing the water supply, 557.—Report, from Mr. Conybeare, in favour of the valley of the Goper, as the only source for an adequate supply, 558.—Quantity of water required, 558.—Admirable sites for storage reservoirs, particularly the basin of Vehar, 558.—Annual rainfall on the Vehar gathering-grounds, and quantity probably available for storage, 559.—Storage capacity of the Vehar reservoir, 560.—Particulars of the three dams by which the water in the lake is impounded, 560.—The

WATER SUPPLY.

waste weir, 561.—Details of the inlet-tower, and of the plans adopted to preserve the greatest possible head of water, in order to admit of the distribution being by gravitation alone, 561.—Filtration considered superfluous, 562.—Design of the summit of the inlet-tower at Vehar, 562.—Dimensions of, and manner of laying, the mains, 562.—Mode of joining the pipes, 564.—Self-closing public conduits, 564.—Names of contractors for different parts of the works, 564.—Sluice-valves, 32 inches in diameter, and smaller valves on Underhay's system, 565.—Conditions under which the work had to be executed, 565.—Difficulty in raising the principal dam to the height required to insure safety, before the setting-in of the first monsoon in June, 1857, 566.

Discussion.—Conybeare, H., 569.—Locke, J., 574.

Bristol, brief description of principal works (Simpson, J.), xiv. 218.

Chalk-water level. "On the periodical alternations, and progressive permanent depression, of the chalk-water level under London." By the Rev. J. C. Clutterbuck, ix. 151.—Definition of the term 'artesioid,' 151.—Artesian wells in Paris, 152.—Present condition of the chalk-water level, 153.—Supposed influx of the tidal waters, 154.

Discussion.—Braithwaite, F., 165, 176.—Clark, T., 179.—Clutterbuck, Rev. J. C., 155, 163, 164, 170, 180.—Dickinson, J., 156, 162, 173.—Faraday, Dr., 160.—Homersham, S. C., 161, 164, 172.—Horn, J., 176.—Playfair, Dr. L., 159.—Simpson, J., 178, 179.—Taberner, J. L., 169, 175.—Ward, F. O., 178.

Glasgow. "On the supply of water to the city of Glasgow." By D. Mackain, ii. (1843) 134.—Cast-iron reservoir at Garnet Hill, 139. *Vide also WATER-works, Glasgow.*

—(Annual Report), xix. 139.

Granite boring. "Account of boring for water through granite." By F. Holland, i. (1839) 44.

WATER SUPPLY.

Land drainage. Effect of the under-drainage of land on the supply of water to rivers, remarks upon, in the course of the discussion on the river Wandle, xx. 210, *et seq.*

Liverpool, and Mr. R. Stephenson's report on ditto (Braithwaite, F.), xiv. 507.

Marseilles (Rennie, G.), xiv. 205. *Vide also AQUEDUCTS, Bridge aqueduct of Roquefavour.*

Melbourne (South Australia). "On the water supply to the city of Melbourne, South Australia; comprising a brief description of the Melbourne gravitation water-works." By M. B. Jackson, xviii. 363.—Situation and population of Melbourne, 363.—Account of the different plans which have been proposed for supplying Melbourne with water, 364.—By Mr. P. Reid, in 1845, 364.—By Mr. Blackburn, Captain Cole, and Mr. J. C. King, in 1850, 364.—Extracts from the report of Mr. Blackburn, as to the capabilities of the river Plenty to supply the city with water, 365.—Mr. Hodgkinson's proposal in 1852, 367.—Modifications recommended in Mr. Blackburn's Plenty scheme by Mr. T. Oldham, 367.—Report of the Select Committee of the legislature, issuing in the appointment of a Commission, which ultimately adopted the river Plenty as the source, 367.—Circumstances under which the works were undertaken, 368.—Description of the river Plenty, of the area draining into it, and character of the 'gathering grounds,' 369.—Loss of water by evaporation, 369.—Description of the Melbourne gravitation water-works, 370.—Works at the junction of the water-course with the river Plenty, 370.—The Yan-Yean reservoir, 370.—Inlet tower, 371.—Fracture of main pipes through the embankment, and mode of remedying it, 372.—Course of the pipes, and works upon the line, 372.—First design of the pressure regulator, 374.—The pressure regulator as used, 375.—Modification of the disc-valve regulator proposed for the Sandridge works, 377.

WATER SUPPLY.

- Facilities for the distribution of the water, 378.—Cost of the works, and mode of meeting it, by a compulsory rate, 378.—Appendix (A.), Report, by Dr. Maund, to the Government, on the waters of the Yarra and the Plenty, 380.—Ditto (B.), Report of analysis of water by Dr. Maund, 382.—Ditto (C.), Table showing the amount of rainfall and of spontaneous evaporation at Melbourne for eight months ending January 31, 1856, 382.—Ditto (D.), ditto at Melbourne and Geelong for twelve months ending January 31, 1857, 383.—Ditto (E.), ditto of rainfall at Ballarat for eight months, and at the Yan-Yean reservoir for four months ending January 31, 1857, 384.—Ditto (F.), ditto of rainfall at Melbourne, Yan-Yean, Geelong, and Ballarat, and of spontaneous evaporation at Melbourne, for twelve months ending January 31, 1858, 384.
- Discussion. — Conybeare, H., 388. — Crampton, T. B., 396. — Fairbairn, W., 400. — Greaves, C., 391. — Hawksley, T., 385, 397, 401. — Locke, J., 403. — Maudslay, H., 401. — Rawlinson, R., 391, 396. — Siemens, C. W., 397. — Töne, J. F., 403.
- Metropolitan, remarks as to the, in course of the discussion on the Government water-works in Trafalgar-square, xix. 30, *et seq.*
- New York (Papworth, J. W.), xiv. 209.
- Plumstead, xiv. 58, 80, 81, 84.
- Steam engine, effects of the introduction of the, for pumping and other accessories in promoting the supply of water to towns (Field, J.), vii. 36.
- Washington (U.S.), aqueduct for supplying the city from the great falls of the Potomac (Annual Report), viii. 179.
- Water rights, remarks upon, in the course of the discussion upon the river Wandle, xx. 250.—Right of ownership in underground water, and of water flowing over the surface, 250, *et seq.*
- Works in progress for supplying water to cities and towns, and bills in Parliament (Bendel, J. M.), xi. 159.

WATER-WHEELS.

- Vide also* AQUEDUCTS; CHALK; LONDON BASIN; RAILWAY STATIONS, Camden; RESERVOIRS; WATER-WORKS; and WELLS.
- Water tanks, cranes, hydrants, and coke stage, necessity for, in connection with railway stations, xvii. 463.
- Water valves, Lambert's flexible diaphragm, vii. 416.
- WATER-WHEELS.
- "On improvements in water-wheels." By I. Dodds, i. (1838) 4.
- "Remarks on machines recipient of water power, more particularly the turbine of Fourneyron." By Prof. Gordon, ii. (1842) 92. *Vide also* TURBINES.
- "An experimental inquiry as to the co-efficient of labouring force in overshot water-wheels, whose diameter is equal to, or exceeds the total descent due to the fall; and of water-wheels moving in circular channels." By R. Mallet, ii. (1843) 60.—Dr. Robison's experiments, 60.—Smeaton's theory, 60.—Diameters of, compared to descent of water, 60.—Description of apparatus for experiments upon, 61.—Value of circular channels for, 62.—Best rate of velocity of, 62, 63.—Practical conclusions relative to, 62.—Positive advantages obtained by the use of circular channels, 63.
- Discussion.—Farey, J., 63.—Homersham, S. C., 64.—Mallet, R., 65.—Rennie, G., 64.—Taylor, J., 64.
- "Description of a water-wheel constructed by Mr. W. Fairbairn, M. Inst. C.E., and erected in Lombardy." By S. B. Moody, iii. 66.—Tension principle for the arms and ventilation of the buckets, 66.—Speed of the wheel, 66.—Comparison of the ordinary and the improved forms of buckets, 67.—Improved governor, 67.—Velocity of wheel increased, 67.—Co-efficient of effect, 67, 68.
- Discussion.—Albano, B., 67.—Glynn, J., 68.—Mallet, R., 67.—Taylor, J., 68.
- History of the introduction and construction of, (Rennie, Sir J.), v. 52.
- "On water-wheels with ventilated

WATER-WORKS.

buckets." By W. Fairbairn, viii. 45.—Substitution of iron for wood, as a material for their construction, 45.—Introduction of overshot and breast-wheels, 45.—Dr. Robinson's observations on bucket-wheels, and on obstructions to their motion, 46.—Best proportion of the opening of the bucket, 46.—Means adopted for removing the air from the buckets of overshot-wheels, 48.—Iron water-wheels, of 120 H.P., at the Catrine and Deanston works, and modifications in their construction, 48.—Means adopted for clearing the buckets of air, in filling, and for facilitating its readmission, in discharging, in a breast-wheel, at Linwood, near Paisley, 49.—Inconveniences arising from floods, or from a deficiency in the water supply, 50.—Ventilated water-wheels as adapted to low falls, 51.—The Catrine water-wheels, on the river Ayr, as constructed by Fairbairn and Lillie, 1847, 51.—Mode of construction of iron suspension wheels, by the late Mr. J. O. Hewes, 51.—Process of filling and emptying the buckets of the wheels, 52.—Breast-wheels, with close soles, and ventilated buckets, for high falls, 54.—Water-wheel, of 100 H.P., at Cleator, near Whitehaven, 55.—Common breast-wheel (not ventilated), as constructed by Fairbairn and Lillie, between the years 1825 and 1827, at the Deanston and the Catrine works, 57.—Water-wheels on M. Poncelet's principle, 58.—Improvements in turbines, 59.

Discussion.—Beardmore, N., 62.—Croker, B. W., 61.—De Bergue, C. L. A., 63.—Fairbairn, W., 60, 62, 63.—Glynn, J., 61.—Rennie, G., 59.—Russell, J. S., 63.—Wicksteed, T., 62.

Vide also TURBINES.

WATER-WORKS.

Altona (Annual Report), xix. 151.
Amsterdam, adaptation of volute springs to hydraulic safety valves, for the, (Croker, B. W.), xv. 42.
Bombay (Annual Report), xvii. 78.

WATER-WORKS."

Cornish engine, application of the, to, i. (1838) 7.

Cranston-hill, ii. (1843) 135. *Vide also* WATER-WORKS, Glasgow.

East London 'stand-pipe' (Wicksteed, T.), iii. 214.

Glasgow. "On the supply of water to the city of Glasgow." By D. Mackain, ii. (1843) 134.—Supply of water in 1755, 134.—Plans proposed in 1780, 134.—Bell's project for bringing water from the falls of the Clyde, and his reasons for rejecting the use of steam engines, 134.—Harley's speculation for pumping-up water and carting it through the streets of Glasgow, 134.—Water company formed, 135.—Telford's report on the proposed plans, 135.—Estimated quantity of water required for Glasgow, 135.—Steam engines for pumping, erected in 1806, 135.—History of the Cranston-hill water-works, the opposition to, and final junction with the Glasgow water company, 135.—Natural filter in the sandy peninsula opposite the works, 135.—James Watt consulted, and ball and socket joints introduced by him for the pipes crossing the Clyde, 135.—Telford's experiments on the strength of stone pipes for the water company, 135.

Discussion.—Braithwaite, F., 138.—Hawkins, J. L., 138.—Simpson, J., 136, 138.

Glasgow. "Description of a cast-iron reservoir erected at Garnet-hill, by the Glasgow water-works company." By D. Mackain, ii. (1843) 139.—Reasons for adopting cast iron, 139.—Bottom constructed of Arbroath pavement and Roman cement, 139.—Thickness of plates, 139.—Lead pipe filled with mixture for the flanch joints, 139.

Discussion.—Simpson, J., 140.

Glasgow (Annual Report), xvii. 76.—Construction of thirteen miles of tunnels for the, (Bateman, J. F.), xix. 279.

Hampstead, new well for, xiv., 74, 89.

History of, (Rennie, Sir J.), v. 58.—Means of obtaining water in the middle ages, 58.—Principal modern water-works,

WATER-WORKS.

enumerated, 58.—Improvements introduced in, during the nineteenth century (Simpson, J.), xiii. 198.

Liverpool Corporation. "Description of the Liverpool Corporation water-works." By T. Duncan, xii. 460.—General description of the site of the town of Liverpool, 461.—Brief history of the various companies for supplying water to Liverpool, 462.—Works of the Bootle company, 463.—Wells formed by the late companies, amount of supply derived from them, dimensions of the engines, and details of the pumps at the Bootle station, 465.—At the Devonshire-place station, 465.—At the Coppas-hill station, 466.—At the Bevington Bush station, 467.—At the Soho-street station, 467.—At the Water-street station, 468.—At the Windsor station, 469.—Reservoirs formed by the Bootle company, 470.—Conflagrations in Liverpool about the year 1840, 470.—Details of the Greenlane works commenced in 1844, 471.—The engine, boilers, standpipe, and pumps, 472.—Cooling ponds for economizing water, 475.—Reservoir at Kensington, 476.—Construction of the embankments and slopes, 476.—Fire arrangements, 477.—Water used for watering the streets, 478.—Table of the number of fires and amount of property destroyed, from 1840 to 1852, 479.—Plan adopted for the suppression of fires, 480.—Corporation, in 1847, for the purchase of the works of the water companies, 481.—Mains of the former companies, 482.—Mains laid for the Greenlane works, 484.—Lead supply pipes from the services, 484.—Meters for regulating supply to manufactories, 485.—Supply to ships, 486.—Hose for the dock service, 487.—Particulars of additional engine at Greenlane, 488.—Observations on pump valves, 491.—Cost of pumping at the different stations of the Liverpool water-works, 493.—Results of trials of coal and slack tested at Greenlane works, 494.—Additional bore-hole at Greenlane, and gradual increase in quantity

WATER-WORKS.

of water yielded, 495.—Formation of the strata, 496.—Quantity of rainfall in Liverpool in 1850 -1, and -2, 497.—Districts kept under constant service, and amount of supply by intermittent and constant systems, 497.—Observations on the flow of water through the main leading from Greenlane to Kensington, 499.—Appendix, experiments on the flow of water through lead pipes, 501.—Ditto, analyses of waters at Bootle, Windsor, and Greenlane stations, 502.

Discussion.—Bateman, J. F., 503.—Gibbs, J., 504.—Homersham, S. C., 503, 504.—Mackain, D., 504.—Rendel, J. M., 505.—Stephenson, R., 504.

Malta, Coradino tank (Arrowsmith, W. L.), ii. (1843) 140.

Manchester (Annual Report), xvii. 77.—Construction of a tunnel for the, (Bateman, J. F.), xix. 279.

Melbourne gravitation, on the water supply to the city of Melbourne, and the, (Jackson, M. B.), xviii. 363. *Vide* also WATER SUPPLY, Melbourne.

Pipes crossing the river Thames, cofferdams used in laying, xiv. 32, *et seq.*

Reservoirs of, fire-proof coverings for, (Barrett, J.), xii. 269; (Simpson, J.) 269.

Rivington, of the Liverpool Corporation (Annual Report), xvii. 75.

South Staffordshire (Annual Report), xviii. 172.

Trafalgar-square. "On the Government water-works in Trafalgar-square." By C. E. Amos, xix. 21.—Undertaken for supplying the fountains in Trafalgar-square, as well as the public offices, 21.—The first well in Orange-street, and the strata through which it passed, 22.—The second well, in the inclosure in front of the National Gallery, and the strata through which it passed, 22.—The engine-house and tanks, 23.—The engines, 23.—Extensions of the works, 24.—Accident in driving the large bore-pipe, 24.—The new steam engine, 25.—The yield from the springs, and the supply obtained, 25.—Levels

WATERMAN.

of the water in the well in front of the National Gallery, from 1846 to 1856, 25.—Well on the premises of Truman, Hanbury, and Co., 26.—Well at Combe and Delafield's brewery, 27.—Appendix, containing a list of the places supplied, with the revenue derivable therefrom, at the rates previously paid, 28.

Discussion.—Amos, C. E., 30, 51.—Bazalgette, J. W., 42.—Braithwaite, F., 33, 37, 43.—Bruff, P., 38.—Clutterbuck, Rev. J. C., 30, 37, 45, 48.—Hemans, G. W., 37.—Homersham, S. C., 35, 45, 48.—Locke, J., 51.—May, C., 48.—Rawlinson, R., 49.—Tennant, Prof., 37.

Water rights, remarks upon, in the course of the discussion on the river Wandle, xx. 250.

WATERMAN, T. [Election, x. 193; resignation, xvii. 85.]

WATERSTON, J. J. [Resignation, xiii. 134.]

WATKIN, —.

Gold. Extract from a Paper by him, on gold-fields of Victoria (Hopkins, E.), xv. 73.

WATSON, J. [Election, vii. 326.]

WATSON, T. O. [Election, viii. 164.]

WATSON, W. [Election, xii. 109.]

Watson's drain pipes, iii. 171; iv. 78.

WATT, J.

Locomotive engine, his suggestions for a high-pressure (Rennie, Sir J.), v. 69.

Steam. "On the economy of working expansively in crank engines," i. (1839) 44.

Steam engines. His improvements in the steam engine (Rennie, Sir J.), v. 22.—Application of his improved engine for pumping water, 58, 59.—State of his steam engine in 1787, 83.

Water-works. Suggestions relative to the Glasgow water-works (Mackain, D.), ii. (1843) 135.—Ball and socket joints introduced by him for the pipes crossing the Clyde, 135.—Recommended the use of the sandy peninsula as a natural filter, 136; (Rennie, Sir J.), v. 60.

Watt and Telford medals, and Council and Manby premiums awarded. *Vide* PREMIUMS.

Waves, action of, on breakwaters, ii. (1842)

WAVES.

126.—Action of, more prejudicial above low water than below it, 127.—The depth and force of, at Madras, 128.—Action of, at Plymouth breakwater, 128.—Ditto, upon vertical sea defences and cliffs, 129.—Ditto, on various kinds of materials, 130.—Ditto, upon the face of embankments, ii. (1843) 191.—Ditto, upon sea-walls, iii. 120.—Character of, as influencing the best form and materials for the construction of sea-walls, vi. 125.—Effects of, on vertical and sloping sea-walls, 125, 130.—The surf, or shoal-water wave, 126.—Its effect on beaches and artificial sea defences, 127.—Upon the Madras bulwark and breakwater, 127.—Action of, upon moving shingle, 131.

Waves, on the practical forms of breakwaters, sea-walls, and other engineering works, exposed to the action of, (Russell, J. S.), vi. 135. *Vide* also BREAKWATERS.

—, nature, action, and strength of, vii. 329, *et seq.*

—, Mr. Alan Stevenson's marine dynamometer, for testing the force of the, vii. 396.—Waves of the Atlantic, remarks upon Dr. Scoresby's Paper on the, read before the British Association in 1850, xiii. 34, *et seq.*—Observations on the movement of the, off the Scilly Islands, xv. 8.—In the North Atlantic, height of the, xvii. 326, 338, 346.—Off the Cape of Good Hope and off Cape Horn, height and velocity of the, 339.—Classes of, to which sea works are exposed, xix. 651, *et seq.*—Present theoretical division of waves, into waves of translation and of oscillation, 659, 667.—Suggested classification of, 660, 667.—Expedients adopted by the Mount's Bay boatmen, and by the Esquimaux, to break the crest of the surface, or ocean-wind waves, 661.—Depth to which the action of, extends, 666, *et seq.*—Experiments for determining the height which waves attain, xx. 361. *Vide* also BREAKWATERS; COASTS; HARBOURS; HARBOURS OF REFUGE; and NORTH SEA.

WEALLEN.

WEALLEN, W. [Election, xvi. 226.]

Locomotive engines, performance of the double-tank, on the Giovi incline, xv. 373.

Wear, river, account of the progressive improvement of Sunderland harbour and the, (Murray, J.), vi. 256. *Vide* also DOCKS, Sunderland; and RIVER WEAR.

WEAVER, W. [Election, x. 192.]

Weaving shed, on one floor, ii. (1842) 143.

WEBB, Captain T., B.E. [Election, xi. 148.]

WEBB, E. B. [Election, xviii. 72; Council premium, xx. 121.]

Public works in Brazil. "On the means of communication in the empire of Brazil, chiefly in reference to the works of the Mangaratiba Serra road, and to those of the Mauá, the first Brazilian railway," xix. 240. — Remarks, 255. — San Paulo railway, 255. — Cost of a bridge on the Serra road, and use of the double-headed rail on the Mauá railway, 256. — Common labour of the country, 260. — Reasons which operated unduly to increase the cost of the bridge of cut stone, 260.

WEBB, F. O. [Election, xvi. 309; Council premium, xviii. 174.]

Harbour, Alderney, so-called 'unknown' rock in, xx. 67.

Telegraph cables. "On the practical operations connected with paying out and repairing submarine telegraph cables," xvii. 262. — Remarks, 301. — The Atlantic Telegraph cable not tested under water, 307. — Table of the comparative strength of ordinary and galvanized iron wire, 307. — Comparative difficulty of paying out and of repairing cables, 350. — Statistics of the success, or failure, of the submarine cables hitherto submerged, or attempted to be laid, 351. — Loss, or waste of cable, and the decrease of tension from letting the cable run out faster than the ship advances, 352. — Decrease of tension by reducing the specific gravity of the cable, 353. — Construction of submarine cables, and lateral protection and permanent

WEBSTER.

strength afforded by the spiral 'lay' of the metallic sheathing, 353. — Relative merits of light and heavy cables, 353. — Mechanical contrivances for paying out a cable, 355. — Objections to the proposed system of paying out a cable from the centre of oscillation, 355. — Best angle at which to pay out a cable, 356. — Effect of increasing the sectional area of the conductor, 356. — The reception of an electric current used as a test for insulation, in paying out the Atlantic cable, 357.

Telegraph cables. Maintenance and durability of submarine cables, xx. 67. — Red Sea and Indian telegraph cables, 68.

WEBB, W. L. [Election, xiv. 42.]

WEBSTER, T.

Coasts, &c. Formation of Dungeness Point, xi. 220.

Fuel. Use of coal and coke in engine furnaces, xvi. 35.

Furnaces, admission of air to, xiv. 27.

Girders. "On Mr. Hodgkinson's experiments on cast-iron girders," i. (1837) 30.

Harbours, the entrances to, how to be kept free of deposit, xv. 452.

India-rubber, necessity for experiments on the capabilities and properties of vulcanized, xiii. 435.

Junction of the Atlantic and Pacific oceans, practicability of a, by the valley of the Atrato, xv. 409.

Locomotive engine, Mr. Beattie's coal-burning, xvi. 35.

Materials, strength of. "On experiments on the strength of materials," i. (1837) 27.

Patent-law reform, x. 209, 217.

Railways, guarantees to, and suggestions for obtaining a resolution of the House of Peers, rescinding the Standing Order as to the guarantee clauses, xviii. 41.

Steam. "On the results obtained by Mr. G. H. Palmer, respecting the maximum duty of a given quantity of atmospheric steam," i. (1837) 41.

Steam boilers, explosions of, xv. 305.

WEDGES.

- Wedges, wood, compressed, by Ransome and May's process, ii. (1842) 78, *et seq.*
 —, uncompressed, ii. (1842) 78.
 Weighing sunken vessels. Account of the plan employed for raising the 'Innisfail' steamer, sunk in the river Lee, near Cork (White, G. P.), iii. 283.
 Weights, measures, and coins, on the French system of, and its adaptation to general use (Yates, J.), xiii. 272. *Vide DECIMAL COINAGE, ETC.*
 Weirs, experiments on the discharge of water by overfalls, or (Blackwell, T. E.), x. 331.
 —, oblique, on the river Severn, iv., 112.
 —, —, and locks, account of the, erected for the improvement of the navigation of the river Severn (Williams, E. L.), v. 340; vii. 245.
 —, —, —, account of the weir and locks constructed on the river Severn, at the Upper Lode near Tewkesbury (Williams, E. L.), xix. 527.
 WELBANK, Captain.
 Beacons, caissons, and lighthouses proposed for the Goodwin Sands, vii. 138.
 Screw-piles and moorings, vii. 138.
 Sea-lights. Statement that lightships were in the habit of parting their moorings, vii. 139.
 WELCH, H. [Resignation, xiv. 108.]
 Well at Barclay's brewery, water 3° hotter at the bottom than at the surface, ii. (1843) 143.—Cause of the diminution of the water in, ix. 169.
 — Chelsea, ii. (1842) 65.
 — Cheshunt, hot sulphurous spring, ii. (1843) 143.—Influence of local circumstances on temperature, 143.
 — Chichester, depth of, ii. (1843) 142.
 — Colchester, into the chalk, with a list of the strata passed through, xix. 38.
 — Combe and Co.'s, ix. 165; xix. 44.
 — Epping, ii. (1842) 163.—Supplied by a land spring, and not from the sand water, ii. (1843) 156.
 — Glasgow water-works, difficulties encountered in sinking, ii. (1843) 137.
 — Hampstead - road reservoir, i. (1839) 62; ii. (1843) 58; xiv. 74.
 — Hanwell, ix. 179.

WELLS.

- Well at Kingston Union, affected the level of water in Mr. Palmer's well, ii. (1843) 164.
 — Lambert's brewery, v. 204.
 — Liverpool, *Vide WELLS.*
 — London, *Vide WELLS.*
 — Meux's brewery, ii. (1842) 162; (1843) 58.
 — Page's brewery, Greenwich, v. 203, 204.
 — Portsmouth, xix. 32.
 — Ramsgate, xix. 32.
 — Reid's brewery, ii. (1842) 164; (1843) 57, 58; viii. 185.
 — St. Alban's, water hotter at the bottom of the well than when pumped up, ii. (1843) 148.
 — Southampton must probably be sunk much deeper to obtain a supply of water, ii. (1842) 163.—Temperature of water, (1843) 142.—Depth of, 142.
 — Tottenham, ii. (1842) 163.
 — Trafalgar-square, ix. 169; xix. 21, *et seq.* *Vide also WATER-WORKS, Trafalgar-square.*
 — Truman, Hanbury, Buxton and Co.'s brewery (Davison, R.), ii. (1842) 192; (1843) 57.
 — Wandsworth, Lunatic Asylum, ii. (1843) 165.
 — Watford, ii. (1842) 159.
 WELLINGTON, Duke of. [Election, ii. (1842) 184; memoir, xii. 126.]
 'Wellington' bridge, over the river Aire, at Leeds (Timperley, J.), iii. 104.
 WELLS.
 Artesian, supply of water from, (Mylne, R. W.), i. (1839) 59, *et seq.*, 158, 159. *Vide also ARTESIAN WELLS.*
 . Boring. "Description and drawing of an apparatus designed by Mr. Mitchell for boring wells." By Mr. Mitchell, Jun., i. (1837) 18.
 Deep wells under and near London, and the analyses of their waters (Braithwaite, F.), v. 203; viii. 178, *et seq.*; xix. 21, *et seq.*
 Infiltration of salt water into. "On the infiltration of salt water into the springs of wells under London and Liverpool." By F. Braithwaite, xiv. 507.—Analyses

WELLS.

- of water of wells at Tring, Watford, and Camden Town, 507.—Mr. Robert Stephenson's report on Liverpool water supply, 507.—Chemical condition of Liverpool water, 508.—Analyses of water of wells at Camden Town, Minories, and Trafalgar-square, 509.
- Discussion.—Braithwaite, F., 512, 519, 522.—Campbell, D., 518, 522.—Clutterbuck, Rev. J. C., 510.—Homersham, S. C., 515, 522.—Simpson, J., 512, 522.—Stephenson, R., 521.
- London and North-Western railway, wells at the Tring, Watford, and Camden stations of the, analyses of the water from the, (Dockray, R. B.), viii. 172.
- Point of Ayr, sunk for foundations for a lighthouse (Walker, J.), ii. (1842) 65.
- Sinking. "Description of the mode adopted for sinking a well, at Messrs. Truman, Hanbury, Buxton, and Co.'s brewery." By R. Davison, ii. (1842) 192.—Cylinders broken, 193.—Blow of sand, 193.—Internal cylinder, 193.—Supply of water from the different levels and springs, 194.
- Discussion.—Braithwaite, F., ii. (1843) 57, 58, 59.—Clark, T., 59.—Davison, R., 58.—Farey, J., 58, 59.—Mylne, W. C., 59.—Taylor, J., 59.—Vignoles, C., 58.
- Sinking, expansion of the clay in, (Braithwaite, F.), iii. 147.—Method of forcing the cylinders into wells (Clark, T.), 201.—Metal cylinders of uniform diameter can be carried down 60 or 70 feet (Simpson, J.), iv. 249.—New system of boring tried with success at Perpignan (Buckland, Dr.), vi. 195.—Blasting in, (Clark, T.), x. 295.—Difficulty of sinking in sand (Braithwaite, F.), xiii. 477.
- , in India, ii. (1842) 63; xvi. 455.
- Vide also* BRIDGES, FOUNDATIONS OF.
- Trafalgar-square water-works, wells for supplying, (Amos, C. E.), xix. 21, *et seq.*
- Vide also* ARTESIAN WELLS; CHALK; LONDON BASIN; RAILWAY STATIONS, Camden; WATER SUPPLY; and WATER-WORKS.

WHEATLEY.

- WELLS, G.
Breakwaters and piers. Design for a breakwater, combined with a landing stage, to be constructed of iron and wood, xviii. 104.
- WELLS, Colonel J. N., C.B. [Memoir, xiv. 159.]
- WERTHEIMBER, —.
Calculating machines. Dr. Roth's automaton calculator, iii. 68.
- WEST, —.
Diving apparatus, helmet, xv. 327.
- WEST, C.
Telegraph cables, use of india rubber as an insulating material for, xx. 76.
- WEST, F. W. I. [Election, xix. 263; memoir, xx. 159.]
- WEST, W. [Election, i. (1839) 37.]
- WEST, W. [Election, ii. (1842) 72; Telford medal, vi. 2; memoir, xi. 112.]
- Coal mines. "A comparative view of the recorded explosions in coal mines," x. 1.
- Locomotive engines. "On water for locomotive engines, and its chemical analysis," v. 182.
- Tunnels. "On the ventilation of tunnels," i. (1838) 32.
- WESTERN, Lieutenant J. R. [Election, ii. (1842) 72.]
- WESTMACOTT, P. G. B. [Election, xx. 586.]
- Westminster bridge, history and construction of, (Whishaw, F.), i. (1838) 44.
- , coffer-dam round the 13 feet and 14 feet piers of (Pollock, Lieut. F.), i. (1839) 66.
- WETHERED, Honourable J. (U.S.)
Steam. "On combined steam," xix. 462.
— Remarks, 468. — Experiments in H.M.S. 'Dee,' 468. — Superheated steam, and apparatus for applying it in the 'Valette' and H.M.S. 'Dee,' 485. — Use of mixed steam, 486. — Reports of trials of the system made by the French, the British, and the United States Governments, 487.
- Wharfing, cast-iron, adopted at the Victoria (London) docks, xviii. 482.
- WHEATLEY, Captain.
Artillery. Experiments in the United States against iron plates, xix. 400.

WHEATSTONE.

WHEATSTONE, Professor.

Electric telegraph. Application of electricity for telegraphs, ii. (1843) 30. — Electro-magnetic signal telegraphs for the Aix-la-Chapelle railway, 181.

Telegraph cables. Main features of the submarine cable between Dover and Calais shown in a drawing prepared under his direction (Crampton, T. R.), xvi. 206.

Wheatstone's parallelogram, as employed in comparing the resistance of two wires, xx. 39.

WHEELS.

"On the teeth of wheels." By R. Willis, i. (1838) 29.

"On a method of setting out involute teeth of wheels, so that any two wheels of the same or of different diameters will work truly together, whether the teeth bottom or only just touch each other." By C. Cowper, i. (1841) 60.

Wheels, railway carriage, description of a machine for bending and setting the tire of (Woods, J.), i. (1841) 99.

Whewell's, Dr., observations on the tidal phenomena of the North Sea, xx. 350, *et seq.*

WHIGHCOCK, J. [Election, xi. 299.]

WHIBLOW, F. [Telford medal, i. (1839) 9; memoir, xvi. 143.]

Bridges. "History and construction of Westminster bridge, accompanied with detailed drawings," i. (1838) 44.

Electric telegraph. Underground and overground systems of laying wires, xi. 371, 375.—Dr. Dujardin's magneto-electric apparatus, 372.—Electric telegraph instruments, 376.

Fire-proof buildings. Division of large buildings by party-walls, the best preventive to the devastation of fires, viii. 148.—Fire-proof safes, 148.

Junction of the Atlantic and Pacific oceans, size of tunnels in the United Kingdom compared with those on the proposed ship canal by the valley of the Atrato, xv. 405.

Lamps, camphine, viii. 232.

WHITE.

Looks and keys. Lock in which electro-magnetism is combined with the ordinary mechanical principles, xiii. 268.

Permanent way, viii. 271.

Railway sections. "Manchester and Leeds railway section," i. (1839) 48.

Railways. "Observations on the present mode of executing railways, with suggestions for a more economical, yet equally efficient system of both executing and working them," i. (1839) 53.

Timber, preservation of. White ant of India, ix. 49.

Uniform time. General adoption of Greenwich mean time throughout the country, iv. 71.

Whistle, signal, for railways and other purposes, Porteous', iv. 150.

Whitby stone, strata of, (King, N.), i. (1838) 20.

WHITE, Dr. D. B.

Colliers, water-ballast for iron screw (Simpson, J.), xiii. 196, xiv. 329, 349, 365.

WHITE, G. [Election, i. (1838) 21.]

WHITE, G. [Election, ii. (1842) 138.]

WHITE, G. F. [Auditor, xii. 111; xiii. 122; Telford medal, xii. 116; Member of Council, xv. 76.]

Cements. "Observations on artificial hydraulic, or Portland cement; with an account of the testing of the brick beam erected at the Great Exhibition, Hyde Park," xi. 478.—Remarks, 505.—Distinction between 'natural' and 'artificial' cements, 504.—Paper by Dr. Schafhaeutil on cements, 508.

— Injection of Portland cement into the foundations of the Pont de l'Alma, xvi. 440.—Calcination of cements at a high temperature, especially Portland cement, xvii. 435.—Ultimate induration of Portland cement, 437.—Whether the presence of iron, in combination with limes and cements, promotes their 'hydraulicity,' 437.

Concrete blocks at Dover, Marseilles, Cherbourg, &c., xvi. 440, 442.

WHITE, G. P. [Resignation, xiv. 108.]

Wrecks, raising. "An account of the plan employed for raising the 'Inuis-

WHITE.

fall' steamer, sunk in the river Lee, near Oork," iii. 286.

WHITE, J. B., Jun. [Election, i. (1841) 80.]

Whitehaven pier, construction of, vi. 146.

WHITEHOUSE, W.

Submarine telegraphs. Different and distinct waves of electricity co-existing in long submarine conductors at the same instant of time, xvi. 215.—Laws of the transmission of electric signals in submarine lines, 215.—Lateral induction between wire and wire, 217.

WHITMORE, W. R. [Election, i. (1838) 122.]

Whitney's (J. D.) "Metallic Wealth of the United States," extract from, as to the gold districts of Virginia, U.S., xv. 69.

WHITTON, J. [Election, xiii. 421.]

WHITTY, Captain J. S. [Election, xi. 299; resignation, xvii. 85.]

WHITWORTH, J. [Election, i. (1841) 80; Member of Council, xv. 76; xvi. 88; xvii. 70; xviii. 164; xix. 132; xx. 108.]

Artillery. His system of rifled cannon, the metal used in their construction, the operation of loading, the projectiles employed, and their range and penetration, xix. 396.—Strength of the material used for the Whitworth rifles, 398.—Experiments against iron plates, 397, 399.—Construction of his 80-pounder gun, 398.—Degree of rifling adopted in the Whitworth guns, 399.—Rifling of the service brass guns, 406.—Suggested competitive trials of Sir W. Armstrong's and Mr. Whitworth's guns, 422.—Difference between Sir W. Armstrong's rifled ordnance and projectiles and his own, 423.—His 12-pounder breech-loading gun, the projectiles used with his rifled ordnance, the metallic cartridge, and the mode of working the gun, 423.—Comparison of ranges of the two guns, 427.

Electric telegraph. Extract from his report on the New York Industrial Exhibition, as to electric telegraphs in United States, xi. 384.

WICKSTEED.

Fire-arms. Effect of twist in rifles, xix. 400.—Diameter of bore adopted in his rifle, 400.

Locks and keys. Ohubb's locks, ix. 389.

Machinery of the United States, his report upon the, with instances of the subdivision of work in America, xvii. 19.

Machines. Batho and Bauer's small planing-machine, xvii. 192.

Measuring-machine for determining minute differences of length, x. 325.

Roads. Macadamized road at Albert Place, Manchester, xiii. 231.

Screws. "On a uniform system of screw threads," i. (1841) 157.

— Screwing dies, ii. (1843) 145.

Street-cleansing. Sweeping machine, ii. (1843) 203; vi. 431; xiii. 225.

— "On the advantages and economy of maintaining a high degree of cleanliness in streets and roads, with an account of the construction and operation of the street-sweeping machine," vi. 431.

Whitworth and Armstrong guns and projectiles, *Vide* ARTILLERY; and DEFENCES, NATIONAL.

WICKSTEED, T. [Telford medal, i. (1839) 6; Member of Council, i. (1840) 36; (1841) 52; ii. (1842) 51; (1843) 67.]

Drainage of towns. Plan for using the sewage-water of London, vii. 90.—System proposed for the sewerage of Berlin, 91.

—Sewerage of towns, and utilisation of the products of the sewers, 90, 103.—Proposition for substituting circular sewer pipes, of small diameters, for the present sewers, 103. Extract from his reports, as to mode of dealing with the sewage matter of the metropolis (Bidder, G. P.), xii. 89.

Engine-counters, vii. 78.

Engines. "On the Cornish engines," i. (1838) 2.

— Work done by the steam engine at Old Ford, i. (1840) 15.—Effect of the rate of working, 15.—Duty of, 16.—Comparison of duty done by a Cornish engine, and an ordinary water-works engine, 23.—Duty of the Old Ford

•WIEN-RAAB•

engines, 78.—Difference in duty of the Cornish double expansive engines, and of the single pumping engines, 79.—Experiments at the Old Ford engine, ii. (1842) 107.—His work on steam engines (Homersham, S. O.), (1843) 196.

Indicator, Moseley's constant, ii. (1842) 107.

Pump valves, ii. (1843) 198.

Water supply. Analysis of water taken from the river Lee, viii. 184.

Water-wheels with ventilated buckets, viii. 62.

Water-works. Mode of raising the 'stand-pipe' of the East London water-works, iii. 214.

'Wien-Raab' ordinary goods locomotive engine, xv. 44.

WIGHTMAN, —.

Crane used at Granton pier, iii. 212.

WIGHTMAN, A. [Election, xii. 352.]

Railways breaks, xix. 519, 524.

Railways, London and Blackwall, wire rope used on the, v. 159.—Machinery in connection with, 159.—Failure of hempen ropes, 159.—Cost of working, 160.

WILD, C. H. [Election, vii. 75; resignation, xiv. 108.]

Bridges. Compressive strain on the top of the Torksey tubular bridge, ix. 253.—Importance of the effect of the continuity of the girders, and the additional strength gained by it, 254.—Effect of the tensile strain on the top of the girder, 267.—Advantages of a continuous side over a lattice, 357.

Exhibition in 1851, construction of the building for the, x. 172.

Girders, Warren, adopted in the construction of the Newark Dyke bridge, on the Great Northern railway, xii. 601.

Railway switch, vii. 210.

WILKIE, G. [Election, xii. 352; memoir, xvii. 106.]

WILKINS, R. [Memoir, xvi. 170.]

WILKINS, W. [Election, ii. (1843) 105.]

Lighthouses, effects of gales of wind on Edystone and Maplin Sand, vii. 155.

WILLIAMS.

WILKINS, W. O. [Election, ii. (1842) 184.] Lighthouses, vibration of Maplin Sand and Edystone, ii. (1842) 151.

WILKINSON, J. J. [Election, xi. 68; Telford medal, ii. (1843) 6.]

Ships and steam vessels. "An historical account of wood sheathing for ships," i. (1841) 98.

— "On lead sheathing for ships," i. (1841) 182.

— "An historical account of copper sheathing for vessels," ii. (1842) 65.

— "On iron sheathing, broad-headed nails, and inner sheathing for ships," ii. (1842) 168.

WILLET, J. [Election, xii. 109.]

WILLIAMS, A. [Election, vi. 481.]

WILLIAMS, O. C. [Election, ix. 282.]

WILLIAMS, O. W. [Telford medal, i. (1840) 6.]

Boats. "Description of the 'Nonsuch' iron passage-boat plying on the Limerick navigation, between that place and Killaloe," i. (1840) 28.

Coal, analysis of, i. (1839) 37.

Fuel, resin, i. (1839) 84.

— "On the properties and composition of the peat and resin fuel," i. (1839) 38.

—, peat, i. (1839) 69.

Furnaces, admission of air to, xiv. 22.

Marine engines, causes of accidents to the main shafts of, xiii. 468.

Naval construction, &c. Iron ships, ii. (1843) 178.—Introduction of iron water-tight bulkheads, and their advantages, 179.

Smoke, prevention of, his apparatus for the, (Simpson, J., Jun.), xiii. 391.

— "On the management of engine-furnaces, with a view to the prevention of the waste and nuisance from smoke," xiii. 397.—Remarks, 403.—Several divisions of the process, leading to the combustion of the gases in furnaces, 403.—Provision of the requisite quantity of air, 404.—Mr. Prideaux' perforated door, 409.

— Principles of smoke prevention, xiv. 23.

Steam boilers. Sight tubes for marine

WILLIAMS.

- boilers, ii. (1842) 154.—Duration of the boiler of the 'Garry Owen' iron steamer, ii. (1843) 179.
- Smoka, explosions of, quotation from his opinion as to, (Woodcock, W.), xv. 290.
- WILLIAMS, E. L. [Election, v. 478; Telford medal, vi. 2; Council premium, xx. 121.]
- Rivers and estuaries. "Account of the works lately constructed for improving the navigation of the river Severn, with their effect in discharging the flood waters," v. 340.—Remarks, 357.—Effect of the Diglis weir, 357.
- "Account of the works recently constructed upon the river Severn, at the Upper Lode, near Tewkesbury," xix. 527.—Remarks, 540.—Construction of weirs in a tidal river, and the position of the lowest weir, so as not to obstruct the tidal flow, and to facilitate the passage of the flood water, 540.—Effects of the oblique weirs on the river Severn, 541.
- WILLIAMS, E. L., Jun. [Election, xix. 263.]
- WILLIAMS, M. B. [Election, xiv. 523.]
- WILLIAMS, R. P. [Election, xx. 375.]
- WILLIAMS, W. [Election, xviii. 72.]
- WILLS, Captain P. W., B.E. [Election, i. (1840) 22.]
- WILLIS, Professor. [Election, i. (1838) 89.]
- Bridges, effect of the velocity of the moving load, ix. 269.—Effects of impact on large structures built of elastic materials, 274.
- Wheels. "On the teeth of wheels," i. (1838) 29.
- WILMOT, Colonel EARDLEY, R.A.—*Vide* EARDLEY-WILMOT, Colonel, R.A.
- WILSON, D. [Memoir, ix. 102.]
- WILSON, E. B. [Election, viii. 164.]
- WILSON, G. F.
- Smoke, prevention of, mechanical means for the, from engine-furnaces, xiii. 406.
- Results attending application of smoke-prevention apparatus at Price's patent candle factory, xiv. 23.
- WILSON, H. C. [Election, xviii. 296.]
- WILSON, J. [Election, iii. 66; memoir, xi. 112.]

WINDER.

- WILSON, J.
- Shingle movement of, xi. 213.
- WILSON, J.
- Gold. Extract from his 'Notes on the Gold Regions of California,' as to the Sonora Diggings (Hopkins, E.), xv. 71.
- WILSON, J. [Election, xix. 263.]
- WILSON, J. W.
- Machine in use at the Midland Counties company's works, at Banbury, for rounding timber, xvii. 40.
- WILSON, W. [Election, viii. 261.]
- Permanent way. Use of Fowler's joint-chairs on Lincoln branch of Manchester, Sheffield, and Lincolnshire railway, xi. 285.
- Wilson's system of coal-burning in locomotive engines, on the Oxford, Worcester, and Wolverhampton railway, 553.
- WIMSHURST, H.
- Colliers, screw and sailing, xiv. 370.
- Ships and steam vessels. Application of screw-propeller to full-rigged ships, xiv. 394.—Importance of giving fine lines to all auxiliary screw steam-vessels, xvi. 337.
- Winch, or small crab, capable of lifting half a ton, xviii. 231.
- Wind, force of, exerted at regular intervals, i. (1841) 79.—Smeaton's table of the force, velocity, and work performed by, v. 289, 290.—Dr. Lind's wind-gauge, 290.—Effects of different winds on Smeaton's oil windmill at Austhorpe, 291.—Table by Smeaton of the velocity of the wind under different circumstances, 292.—Comparison of the opinions of Dalrymple and Smeaton on the velocity of, 293.—Estimates as to the power of the, xv. 7.
- and current charts, value of, xiv. 410.
- Wind-mills, Smeaton's experiments and reports on, v. 21.
- WINDER, T. R. [Election, xvi. 309.]
- Breakwaters and piers. Report of the Select Committee on Harbours of Refuge, dated 17th June, 1858, particularly as to the upright wall system for making breakwaters, illustrated by reference to the works of the Admiralty Pier at Dover, xviii. 91.—Plan for

WINDOW.

constructing an upright wall break-water, and proposed staging and machinery for deep-water works, 93.—Pier in Rye Bay, 97.

WINDOW, F. R. [Election, x. 57; Telford medal, xii. 115; Council premium, xvii. 80.]

Electric telegraph. "On the electric telegraph, and the principal improvement in its construction," xi. 329.—Remarks, 361.—Messrs. Wheatstone and Cooke's double-needle instrument, and Mr. Henley's magneto-telegraph, &c., 361.

— Magneto-electric telegraph, xvi. 208.

Telegraph cables. "On submarine electric telegraphs," xvi. 188.—Remarks, 203.—Difference between simple and compound telegraph-cables, 203.—Mr. L. Clark's experiment relative to the velocity of electrical currents, 207.—Means for overcoming the effects of charge and discharge due to induction, 208.

WINSLAND, N. [Election, ii. (1842) 122; memoir, vi. 5.]

WINSOR, F. A.

Gas. Reasons why Gas Companies prefer low-pressure gas, xvii. 12.

WINTER, T. B. [Election, xviii. 231.]

Wire rope, peculiarities of the, used on the London and Blackwall railway, v. 155.

—, opportunity of testing Newall's, on Oldham incline, x. 248.

Wise's experiments with Melville's propeller, and calculation of a hundred voyages from India and China to England, xiv. 411.

WITHERS, J. [Election, xvi. 226.]

WOLLASTON, C. J. [Election, xix. 461.]

Telegraph cables, submerging, particularly the first experimental line from Dover to Calais, xvii. 309.

Wood, effect of extreme changes of temperature on, xii. 268.

—, on the conversion of, by machinery (Molesworth, G. L.), xvii. 17.

Wood, C. [Election, i. (1839) 33.]

Horse power, economical application of, ii. (1843) 116.

WOODCOCK.

WOOD, H.

Roads, system of macadamizing, adopted at Liverpool, xiii. 236.

WOOD, N. [Member of Council, xv. 76; xvi. 88.]

Air, resistance of, in its passage through tubes, in mines, iv. 280.

Locomotive engine by Stephenson, iv. 286.

Mines, ventilation of, and Government inspection, vi. 193, 196, 204.—The 'goaf,' 203, 204.—Depository of plans of the principal workings of mines, 205.

Railway, atmospheric, iv. 280.

Railway inclines, working of, and amount of adhesion, xv. 371.

Smoke, prevention of, from the ventilating furnaces of the coal mines in the north of England, xiii. 413.—From two ranges of coke-ovens, 414.—How smoke is produced, 414.

Tunnels. Construction of a tunnel through a range of sand-hills near Bolton, xiii. 477.

WOOD, S. [Election, vii. 250; Member of Council, xvii. 70.]

Wood sheathing for ships, historical account of, (Wilkinson, J. J.), i. (1841) 98.

WOODCOCK, W. [Election, xiv. 189.]

Fuel. Comparative experiments as to consumption of different fuels at Messrs. Meux's brewery, xiv. 23.

Furnaces, admission of air to, xiv. 17, 29.

Smoke, prevention of. "On the means of avoiding visible smoke from boiler furnaces," xiv. 1.—Remarks, 14.—Consumption of fuel and work done with his apparatus, 14.—Inverted bridge, 16.—Venetian blind-screen, 16.

Steam boilers. Action of internal flue-firing and of under-firing in the ordinary Cornish boiler, xv. 286.

—, explosions of. Experiments of Franklin Institute Committee, in 1836-7, xv. 288.—Statistics of explosions obtained by Manchester Committee for prevention of boiler accidents, 289.—Ditto contained in report of United States Commissioner of Patents, 289.—Quotation from opinion of Mr. C. W. Williams as to steam-boiler explosions, 290.—

WOODCROFT.

Disadvantage of under-firing, 290.—Quotation from opinion of Dr. Ernst Alban on supposed advantages of an internal flue, 290.—Results obtained by Mr. Wicksteed, from a waggon-headed boiler, with an internal flue and under-fire, 290.—Quotation from opinion of Mr. R. Armstrong, as to injury to the arched-boiler bottom, 291.—Ditto from Mr. W. O. Redfield on boiler explosions, 291.—Opinion that surcharged steam is often the cause of explosions, 291.—Boiler explosion at the Tower Mills, Sheffield, 302.—System of flue-firing, 302.

Water, quotation from opinion of M. Boutigny (d'Yvreux), as to spheroidal state of, at high temperatures, xv. 288.

WOODROFF, B.

Screw propellers, best form of, vi. 293.

Woodcroft's screw propeller (Grantham, J.), iii. 71.

Wooden bearers, results of experiments, made with a view to determine the best figure and position for, so as to combine lightness and strength (Horne, J.), i. (1837) 30.

WOODHOUSE, J. T. [Election, xi. 478.]

Permanent way, effect of the rigidity of, upon the rolling stock, xx. 277.

WOODHOUSE, T. J. [Election, i. (1838) 5; memoir, xvi. 150.]

Woods exposed to a transverse strain, experiments on the strength of various kinds of American, (Denison, Lieut.), i. (1837) 26.

WOODS, E. [Telford medal, i. (1840) 6; election, v. 338.]

Fuel. Original experiment, on the Liverpool and Manchester railway, with anthracite coal, viii. 112.—Evaporative power of different fuels, 113.—Experiments to ascertain the comparative mechanical values of coal and coke, xvi. 27.

Heat. Mechanical equivalent of heat in foot-pounds, xii. 597.

Locomotive engines. "On locomotive engines," i. (1838) 3.

— 'Planet' locomotive, the first of the class of engines with inside cylin-

WORMS.

ders, outside bearings, and cranked axles, xvi. 23.—'Liverpool' four-wheeled coupled engine, with cranked axles and cylinders under the smoke-box, 24.

Railway axles, crystallized fracture of, ii. (1842) 181.

Railway inclines. Comparison of the working of locomotive engines on inclines, xv. 370.—Cost of working the Edge Hill incline, at Liverpool, with stationary engines and rope, 371.

Railway trains, resistances to, methods adopted by Mr. W. Harding for determining the, v. 413.

Roofs, durability of galvanized iron, xiv. 267.

Steam boilers, explosions of, xv. 293.—Locomotive-engine boiler explosions, 294.

WOODS, G.

Steam engines. "On the experiments and results of Mr. W. J. Henwood, as to the power of the Huel Towan engine," i. (1840) 30.

WOODS, J. [Election, i. (1840) 18; memoir, ix. 107.]

Governors. Chronometric governor invented by Messrs. E. W. and C. W. Siemens, v. 255.—Its mode of action, 261.—Necessity of having a perfect valve in combination with a perfect governor, 264.—Clock governor, 264.

Machines. "A machine for bending and setting the tire of railway carriage wheels," i. (1841) 99.

Wool cleansed under exhaustion, Harris's process, ii. (1842) 82.

WOOLFE, A. [Memoir, i. (1838) 9.]

Woollen factory, constructed of cast iron, ii. (1843) 125.

WORDSWORTH, C. F. F. [Election, x. 192.]

Horse power, desirability of fixing the value of term, x. 313.

Patent-law reform, x. 210.

Work, effective, definition of the term, ii. (1842) 118.

Working classes in the United States and in England, xi. 64.

Worms, marine, ravages of, &c., *Vide* Marine worms.

WORSDALE.

Worsdale's apparatus for exchanging letter bags on railways, when the train is in motion, i. (1838) 32.

WORSAM, S.

Machinery for the conversion of wood.

Alleged superiority of American wood-cutting machines, and relative advantages of wooden and iron framework, xvii. 45.—Method of steadying the circular saw, 46.—Planing-machines, 46.

Wort, machine for cooling brewer's (Davison, R.), i. (1841) 57.

WORTHINGTON, S. B. [Election, i. (1839) 54; xx. 191.]

Wrecks, causes of, on the British coast, xv. 20.

WRECKA, SUBMERGED.

Destruction of, by gunpowder, *Vide* BLASTING under water.

Raising. "An account of the plan employed for raising the 'Innisfail' steamer, sunk in the river Lee, near Cork." By G. P. White, iii. 287.

Recovery of property from, xv. 312, 330.

Vide also DIVING APPARATUS.

WRIGHT, H. [Election, xiv. 374.]

WRIGHT, —.

Locomotive engines, experiments on coal-burning in, xix. 566.

WRIGHT, A. [Election, xv. 418; Council premium, xviii. 174; memoir, xix. 183.]

Gas. Comparative quantities of gas produced by the use of clay and of iron retorts, xvi. 316.—Leaking of gas from retorts under pressure, 317.—Formation of the bisulphuret of carbon when gas is made at a high heat, and want of a chemical agent for dissipating that impurity, 318.—Purification of gas, 318.—Comparative cost of clay and iron retorts, 318.

WYNNE.

Mines. "On lighting mines by gas," xvii.

1.—Remarks, 8.—Mode of descent into metallic mines, the present system of lighting by candles, and the adaptation of gas for that purpose, 8, 14.—Distinction between coal and Cornish mines, 9.

WRIGHT, H. T. [Election, iii. 284.]

WRIGHT, J. [Auditor, vii. 74; viii. 44.]

Bridges. Removal of remains of old bridge at Rochester, x. 367.

Coasts, &c. Present artificial accumulation of shingle at Brighton, and works by which it has been accomplished, xi. 214.

Sea-walls, concrete, at Brighton, vi. 132.

WRIGHT, J., Jun. [Election, xvi. 458.]

WRIGHT, L.

Bridges. Project for an iron bridge at Rochester, iii. 65.

WRIGHT, T. [Election, xii. 432.]

Permanent way. His vice jaw chair, xvi. 239.

WRIGHT, W. B. [Election, xviii. 231.]

Wrought iron. *Vide* IRON; and IRON AND STEEL.

WYATT, M. D. [Election, x. 57; Telford medal, xi. 87; Member of Council, xvii. 70.]

Exhibition in 1851. "On the construction of the building for the exhibition of the Works of Industry of all Nations in 1851," x. 127.—Remarks, 190.—To whom merit is due for the design and execution, 195.

WYATT, T. H. [Election, iv. 186; Auditor, v. 160; vi. 57; Member of Council, vii. 56.]

WYLD, J. [Decease, i. (1837) 7.]

WYNNE, A. A. [Election, xx. 258.]

WYNNE, T. [Election, xiv. 42.]

Y.

YARROW.

YARROW, T.

Locomotive engines, experiments on coal-burning in, xix. 560, 571.

YARROW, T. A. [Election, xvi. 226.]

YATES, J. [Telford medal, xiv. 105.]

Decimal coinage, etc. "On the French system of measures, weights, and coins, and its adaptation to general use," xiii. 272. — Remarks, 349. — Statement that the *mètre*, which is the basis of the French system, is an inaccurate standard, 349. — Quotation of opinion of Sir John Herschel as to the *mètre*, 349. — Method of computing the standard of lineal measure by comparing it with the minute of a meridian, 350. — Necessity for providing, in a system of weights and measures, for a division into halves and quarters, as well as into tenths, 350. — Assumed distinction between the decimal system, as applied to coins and to weights and measures, 350. — How far the computations applying to coins apply to weights and measures, 351. — Introduction of the French metrical system into France, 352. — Want of conformity with any previous method, 352. — His table of coinage, 353. — Universal (silver) standard of value, 354. — Complicated question of exchange, 355. — Objections against the adoption of an international monetary system, 356. — Scarcity of instances of the adulteration of coins by any important Government, 357. — Extract from letter of the Hon. R. J. Walker, Secretary of the Treasury (U.S. America), on the state of the finances, Dec. 11, 1848, 357. — Asserted superiority of the pound and mil scheme of coinage, 358. — That a farthing, or mil, does not descend sufficiently low, 358. — Medium of exchange in British North America, the East India Islands, &c., 359. — Relative

YSTALYFERA.

advantages of the French system of coinage compared with the pound and mil scheme, 359. — Advantages of reckoning by francs and centimes, 360. — Professed feelings of 'affection for the pound' sterling, 361. — Assumed difficulty in introducing the French metrical system, 362.

YEATMAN, H. J. [Election, xviii. 406.]

Ynischedwyn iron, made with anthracite and hot blast, ii. (1843) 130.

YOCKNEY, S. H. [Election, xiii. 64.]

YOLLAND, Colonel.

Railway breaks. His report to the Board of Trade, relative to the steam break of Mr. McConnell, the continuous break of Mr. Fay, the continuous and self-acting break of Mr. Newall, and the self-acting break of M. Guérin (Fairbairn, W.), xix. 491.

YORK, J. O. [Election, i. (1840) 75; Walker premium, iii. 7.]

Iron, tendency of cold hammering to produce brittleness in, ii. (1842) 181, 182.

Railway axles, his hollow, ii. (1842) 183. — Tests to which they have been submitted, 183.

— "Account of a series of experiments on the comparative strength of solid and hollow axles," ii. (1843) 89. — Remarks, 91, 107. — Mode of manufacturing his hollow axles, 92. — Causes of injury to iron in working, 93. — Experiments on the effect of checking vibration in axles by keying the wheels on, 107.

YOUNG, F. M. [Election, x. 369; memoir, xx. 159.]

YOUNG, J. [Election, xv. 246.]

YOUNG, S.

Docks. Most convenient angle to the flow of the tide for placing dry docks, and the entrances of wet docks, vii. 176.

Ystalyfera iron, made with anthracite and cold blast, ii. (1843) 130.

Z.

ZINC.

Zinc, on the application of, by the process of electro-deposition, for the purpose of preserving iron, as applied to engineering and other purposes (Pellatt, F.), ii. (1843) 167.

ZOHRAB.

ZOHRAB, E. [Election, ii. (1843) 183; resignation, x. 72.]

LONDON :
PRINTED BY WILLIAM CLOWES AND SONS, STAMFORD STREET
AND CHANCING CROSS.

